AD______________

Award Number: DAMD17-96-1-6299

TITLE: Effects of Endurance and Resistance Training on Cardiovascular Risk in Military Eligible Women

PRINCIPAL INVESTIGATOR: Andrew W. Gardner, Ph.D.
Eric T. Poehlman, Ph.D.

CONTRACTING ORGANIZATION: University of Maryland
Baltimore, Maryland 21201-1691

REPORT DATE: October 1999

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

20000627 150

REPORT DOCUMENTATION PAGE

OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 1999	Annual (25 Sep 98 - 24 Sep 99)

4. TITLE AND SUBTITLE
Effects of Endurance and Resistance Training on Cardiovascular Risk in Military Eligible Women

5. FUNDING NUMBERS
DAMD17-96-1-6299

6. AUTHOR(S)
Andrew M. Gardner, Ph.D.
Eric T. Poehlman, Ph.D.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of Maryland
Baltimore, Maryland 21201-1691

E-MAIL:
epoehlma@zoo.uvm.edu

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 Words)*

The overall hypothesis is that the decline in physical activity habits and resultant increase in body fat reduces exercise capacity and muscle mass in military women. These lifestyle changes worsen cardiovascular risk factors. Therefore, continued involvement in resistance and endurance exercise programs which increases or preserves fat free mass, as well as enhances physical activity will prevent functional declines in military-eligible women. Although exercise is frequently recommended to enhance overall fitness, it is unclear as to whether endurance or resistance exercise is more effective in attenuating functional and cardiovascular declines in women. We will systematically compare the effects of **endurance** and **resistance** exercise on physical activity, cardiovascular fitness, and fat metabolism in military eligible women.

To accomplish this objective, women (18 to 35 yrs) will be randomized to a 6-month endurance training, resistance training or a control group. We will examine the following dependant variables: **1)** free-living physical activity using doubly labeled water and indirect calorimetry; **2)** body composition and body fat distribution using dual energy x-ray absorptiometry and computerized tomography, **3)** in-vivo fat oxidation from ^{13}C palmitate; and **4)** insulin sensitivity from hyperglycemic/euglycemic clamps. Our results will provide new information on the energetic and physiological effects of endurance and resistance training on energy metabolism, cardiovascular fitness and fuel utilization in women.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Women's Health	96
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

FOREWORD

Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the U.S. Army.

✓ Where copyrighted material is quoted, permission has been obtained to use such material.

✓ Where material from documents designated for limited distribution is quoted, permission has been obtained to use the material.

✓ Citations of commercial organizations and trade names in this report do not constitute an official Department of Army endorsement or approval of the products or services of these organizations.

N/A In conducting research using animals, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," prepared by the Committee on Care and use of Laboratory Animals of the Institute of Laboratory Resources, national Research Council (NIH Publication No. 86-23, Revised 1985).

X For the protection of human subjects, the investigator(s) adhered to policies of applicable Federal Law 45 CFR 46.

N/A In conducting research utilizing recombinant DNA technology, the investigator(s) adhered to current guidelines promulgated by the National Institutes of Health.

N/A In the conduct of research utilizing recombinant DNA, the investigator(s) adhered to the NIH Guidelines for Research Involving Recombinant DNA Molecules.

N/A In the conduct of research involving hazardous organisms, the investigator(s) adhered to the CDC-NIH Guide for Biosafety in Microbiological and Biomedical Laboratories.

PI - Signature	Date
	10-12-99

TABLE OF CONTENTS:

INTRODUCTION:

This proposal responds directly to the recommendations for research as outlined by the Institute of Medicine: **Recommendations for Research on the Health of Military Women**. Our proposal specifically addresses the request for research on the effectiveness of different types of physical training programs for women in the military.

Although physical activity is routinely prescribed for military-eligible women, a systematic examination of the effects of different modes of training on women's physiology and work performance has not been undertaken. Specifically, the decline in physical activity and loss of fat-free mass are significant predictors of decreased function and increased cardiovascular risk in military-eligible women. Thus, exercise interventions specifically designed to offset these deleterious changes in work performance, body composition and physical activity are important considerations. All military women initially experience the physical challenges of basic training and once through this experience, the new soldier experiences additional physical challenges that are directly influenced by other military-related activities including, deployment, natural aging, etc. Moreover, given the increased number of career military women retained in the services, strategies to achieve and maintain optimal fitness are of high priority.

Although exercise is recommended to military women, it is unclear as to which type of exercise is most effective in maintaining physical fitness and body composition in an effort to reduce cardiovascular risk and enhance physical function. This proposal will address several health benefits of endurance and resistance exercise in military eligible women in an effort to establish guidelines to maintain optimal cardiovascular and metabolic fitness in military-eligible women. **Results from this study will lay the scientific groundwork for the prescription of endurance and/or resistance exercise as the optimal mode of exercise to maintain physical fitness, work performance and reduce cardiovascular risk in military eligible women.**

The overall hypothesis is that the decline in physical activity habits and resultant increase in body fat reduces exercise capacity and muscle mass in military women. These lifestyle changes worsen metabolic and cardiovascular risk factors. Therefore, continued involvement in resistance and endurance exercise programs which increases or preserves fat-free mass will prevent functional declines in military-eligible women. Although exercise is frequently recommended to enhance overall fitness, it is unclear as to whether endurance or resistance exercise is more effective in attenuating functional and cardiovascular declines in women. We will systematically compare the effects of **endurance** and **resistance** exercise on physical activity, cardiovascular fitness, and fat metabolism in military eligible women. The results of this study will lay the groundwork for appropriate exercise prescriptions to reduce cardiovascular and metabolic risk and enhance physical function in military-eligible women.

1. AIMS AND HYPOTHESES:

AIM #1: To determine the effects of endurance exercise and resistance training on free-living physical activity and cardiovascular fitness in military-eligible women.

AIM #2: To determine the effects of endurance training and resistance training on body composition and body fat distribution.

AIM #3: To determine the effects of low intensity endurance vs resistance training on in-vivo fat metabolism and insulin sensitivity.

2. BACKGROUND AND SIGNIFICANCE

Although increased physical activity is recommended to women, it is unknown as to the type of exercise that is most effective in attenuating functional declines and improving metabolic fitness. We will directly compare the effects of **endurance** and **resistance** training on: 1) free-living physical activity and cardiovascular fitness, 2) body composition and body fat distribution; fat metabolism, and insulin sensitivity in military-eligible women.

(2a) Exercise and Energy Expenditure.

One important reason to prescribe exercise is to increase daily energy expenditure and physical activity to maintain proper levels of body weight and composition. The influence of different types of exercise to achieve this goal has not been systematically examined in women.

Are endurance and resistance exercise effective interventions to increase resting and physical activity-related energy expenditure? A compelling goal of physical training programs is to increase physical activity and energy expenditure. It is presently unknown whether training programs accomplish this goal as physical activity levels outside of the exercise program could not be accurately measured. This proposal will provide new information on the impact of endurance and resistance exercise programs on resting and physical-activity related energy expenditure.

Resting metabolic rate is the largest component of daily energy expenditure in humans (1). A low resting metabolic rate is a significant predictor for body weight gain (2), which may partially explain increases in body weight in women. We have also found the women have a lower resting metabolic rate per kilogram of fat-free mass (3). Collectively, these findings underscore the importance of exercise interventions that would increase resting energy expenditure in women in an effort to offset increases in body weight over time.

It is encouraging to note that both endurance and resistance training has been found to increase resting metabolic rate in women (1). However, its effects on free-living physical activity is of greater interest with respect to regulation of energy balance. Changes in physical activity constitute a large proportion of variation in daily energy expenditure. Moreover, low levels of physical activity is a significant predictor of an increase in body weight over time (4).

We recently performed a study to examine the effects of endurance exercise on free-living energy expenditure outside of the exercise program. We found that women actually reduced their free-living physical activity during non-exercising time in response to endurance training (5). This physiological adaptation is counter-productive to the goals of the military which strive to increase daily energy expenditure through physical exercise. It is possible that the intense level of the exercise program (85% of VO_2 max) may have contributed to this finding. This study raises new questions regarding the optimal exercise mode to enhance free-living physical activity in women. **This proposal will provide new information on the effects of endurance exercise on free-living physical activity by administration of doubly labeled water and the subsequent measurement of free-living physical activity.**

Much interest has recently focused on resistance training as an intervention to enhance muscular strength, restore physical function and reduce cardiovascular risk (6). The impact of resistance training, however, on physical and metabolic function has received less attention than endurance training, particularly in women. Resistance training is an effective stimulus to increase muscular strength and fat-free mass in untrained adults (6). The anabolic nature of resistance training may reverse declines in resting metabolic rate by increasing fat-free mass (7,8). We have no information, however, on the effects of resistance training on free-living physical activity in women. Resistance training may enhance free-living physical activity by several mechanisms: 1) an increase in protein synthesis (9); 2) an increase in sympathetic nervous system (8) and 3) increased levels of fat-free mass. In this study, we will provide new information on the effects of endurance exercise and resistance training as therapeutic interventions to increase free-living physical activity and maintain muscle mass in military-eligible women.

(2b) Exercise, Intra-abdominal Fat and Insulin Sensitivity

What are the effects of endurance and resistance exercise on body fat distribution and insulin sensitivity? We have included in the proposal an examination of the effects of exercise on the metabolic risk factors of insulin and fat metabolism. The rationale for their inclusion is twofold: 1) changes in physical activity and body composition in response to training positively influence these variables and 2) the insulin resistance syndrome is an independent risk factor for cardiovascular (10). It is only recently, however, that the role of exercise to reduce intra-abdominal fat has been examined, and to our knowledge, no information is available in women.

Schwartz et al (11) found that a six month endurance training induced a preferential loss of fat from the abdominal region. Despite the relatively small changes in body weight (<2 kg) and body composition, impressive (>20%) decrements were found in intra-abdominal fat. These changes were associated with improved lipid lipoprotein profiles. Tonino (12) demonstrated an increase in insulin sensitivity with the euglycemic clamp technique in men following an aerobic exercise training program which did not substantially affect body composition. Houmard et al (13) exercise trained 13 middle-aged men, but found that a reduction in central body fat, as measured from the waist circumference, was not related to an improvement in insulin sensitivity. Alternatively, Kirwan et al (14) noted that regular exercise was effective in reducing hyperinsulinemia and improving insulin sensitivity and that these changes were related to the reduction in the waist circumference. Khort et al (15) showed that a higher waist circumference was related to a lower rate of glucose disposal in men. Unfortunately, no systematic investigation of the effects of exercise on insulin sensitivity and body fat distribution has been undertaken in women.

Most studies have focused on endurance training, whereas less attention has been directed towards the effects of resistance training on intra-abdominal body fat and insulin sensitivity. However, because isometric contractions produce insulin-like effects on glucose uptake in skeletal muscle (16) and muscle mass serves as the principal site of glucose disposal, resistance training could be an important intervention to enhance insulin action in women. Recent reports provide support for this hypothesis. Ross and Rissanen (17) found that the combination of energy restriction (1000 kcal/day) and either resistance or aerobic exercise induced significant reductions in intra-abdominal fat. This was a surprising finding given the fact that the direct energy cost of the endurance exercise program was substantially higher than the resistance training program. This finding suggests that changes in the other components of total daily energy expenditure (resting metabolic rate or physical activity) may have occurred that significantly increased the total daily energy expenditure of the resistance training program.

Several investigators examined changes in insulin sensitivity in response to resistance training. For example, insulin responses to an oral glucose challenge were found to be lower in younger individuals after resistance training (18), and in some cases glucose tolerance was improved similarly in endurance and resistance training (19). Miller et al (20) showed that 16 weeks of strength training improved the insulin response to glucose ingestion in young males, which they attributed to an increased muscle mass. Data from our laboratory showed that strength training increased nonoxidative glucose metabolism by 45% in men (21). To our knowledge, no studies have directly compared the effects of endurance vs resistance training on changes in intra-abdominal body fat and associated changes in glucose metabolism in women.

(2c) Exercise and Fat Metabolism.

What are the effects of endurance and resistance exercise on fat oxidation? We feel is it is important to include a measure of fat oxidation in the present study to help explain the mechanisms related to changes in insulin sensitivity. It is reasonable to hypothesize that the loss of intra-abdominal body with exercise training programs will be associated with improvement in insulin sensitivity. This is based on the fact that adipose tissue in the visceral region is highly sensitive to lipolytic stimuli, particularly in those regions drained by the portal circulation (22). As a consequence, increased fat oxidation as a result of exercise would reduce the delivery of free-fatty acids to the liver, thereby reducing gluconeogenesis and stimulating hepatic insulin clearance. This would lead to lower circulating concentrations of insulin and increased insulin sensitivity (23). However, the optimal exercise mode to maximize loss of intra-abdominal fat and improve insulin action has not been clearly established.

The majority of knowledge regarding the effects of exercise on fat oxidation has been primarily derived from endurance training studies and from measurements of circulating concentrations of substrates considered to be representative of lipolytic action (24,25). More recently, we have used in-vivo techniques to quantify fat metabolism in humans. We showed that endurance training increased levels of fat oxidation in healthy women (26). However, less information is available regarding the effects of resistance training on fat oxidation in younger women. Pratley et al (8) showed that 16 weeks of resistance training increased plasma levels of norepinephrine in men, but no changes were noted in fat oxidation. Melby et al (27) showed that resistance exercise elevated postexercise metabolic rate and fat oxidation 15-hr after exercise completion. They suggested that resistance exercise may be beneficial in weight control because of the direct energy cost of the activity, the residual elevation of postexercise VO_2 and the greater post-exercise fat oxidation. Work from our laboratory shows that fat-free mass is an important regulator of the rate of appearance of fatty acids into circulation and fat oxidation in women (28,29). Thus, resistance training may elevate the level of fat oxidation by increasing the metabolic demand for fatty acids by increasing skeletal muscle mass as well as the level of daily energy expenditure and physical activity. This study will provide new insight into the effects of endurance and resistance training on insulin sensitivity and fat oxidation in military-eligible women.

Collectively, this will be the first proposal to systematically examine the effects of endurance and resistance training on a comprehensive battery of cardiovascular and metabolic risk factors in military-eligible women.

3. WORK ACCOMPLISHED:

Intervention Studies

We examined the effects of exercise training on changes in total daily energy expenditure and physical activity. We subjected women to 8 weeks of intense endurance training in which resting metabolic rate, body composition and norepinephrine kinetics were measured (30,31). We found that resting metabolic rate increased by 10% (150 kcal/d), without significant changes in body composition. These results suggest that endurance training increases resting energy needs in women. These results prompted further studies with doubly labeled water to examine the effects of exercise on daily physical activity, the true determinant of energy balance. **These studies document our ability to carry out and retain women in exercise intervention studies.**

We used doubly labeled water to assess the effects of exercise on free-living energy expenditure (5). We found that individuals became more inactive during their non-exercising time in response to a high intensity endurance exercise. We found that endurance training resulted in a 62% reduction in the energy expenditure of physical activity outside of the exercise program (571 ± 383 to 340 ± 452 kcal/d). The results underscore the importance of using doubly labeled water to determine the effects of endurance or resistance exercise on daily energy expenditure in women. **This study documents our ability to use doubly labeled water methodology in exercise intervention studies and raises new questions regarding the type of exercise that is most efficient in increasing physical activity in military-eligible women.**

Fat Metabolism:

In a series of studies, the effects of endurance training on fat oxidation in women were assessed. Free fatty acid appearance rate and fat oxidation were determined from ^{14}C palmitate infusions and indirect calorimetry (26). In response to endurance training, free fatty acid appearance did not change, but fat oxidation increased (200 ± 12 vs 244 ± 16 $\mu mol \cdot min^{-1}$; $P<0.01$). These results support the notion that endurance training increases fat oxidation in the basal state. Furthermore, individuals who increased total daily energy expenditure and physical activity, also showed higher levels of fat oxidation ($r=0.55$; $P<0.05$). **These findings led us to propose to test the hypothesis that significant increases in total daily energy expenditure and physical activity (by endurance or resistance exercise) will enhance fat oxidation, promote loss of intra-abdominal fat and increase insulin sensitivity in military-eligible women.**

Resistance Training:

We examined relationships of resting metabolic rate to cardiovascular disease risk in middle-aged women characterized as resistance trained, aerobic trained or untrained (33). Resting metabolic rate, after normalization for differences in fat-free mass, was 7% higher in aerobic and resistance trained women compared to untrained women. Both aerobic and resistance trained individuals were expending approximately 200 kcal/d more at rest when compared to untrained individuals. These results suggest that resistance and aerobic training can serve as suitable interventions to offset the decline in resting metabolic rate in military women. **We now propose a resistance training study in which daily energy expenditure can be measured to assess it**

relation to enhanced functional capacity and cardiovascular risk factors in military eligible women.

The effects of resistance training, with and without weight loss, on endogenous insulin secretion and peripheral tissue glucose utilization was examined in postmenopausal women (34). Women trained three times per week for 16 weeks on resistance machines. Body composition was measured from dual-energy x-ray absorptiometry. Despite weight loss, fat-free mass was maintained in weight loss groups by concomitant resistance training. The endogenous insulin response decreased 24% with resistance training and 42% with resistance training and weight loss, with no change in glucose utilization. These results suggest that peripheral tissue sensitivity to endogenously secreted insulin improved to a greater extent with resistance training and weight loss rather than resistance training alone. However, resistance training increased insulin sensitivity in both groups. These results suggest that increased adiposity and glucose intolerance associated with the post-menopausal state could be prevented with resistance training and weight loss. **We now propose to study the mechanism of the increase in insulin sensitivity in military-eligible women by examining in-vivo fatty acid utilization and oxidation.**

Significance of Proposed Work. The adaptive responses of military-eligible women to endurance and resistance training has been an understudied area of research. The combined used of doubly labeled water methodology, multicompartment models of body composition, and substrate measures of insulin sensitivity and fat oxidation will provide new information on the effects of resistance and endurance exercise to cardiovascular and metabolic risk factors. Our preliminary data demonstrates our ability to successfully conduct exercise studies in women, perform sophisticated measured of energy expenditure and substrate metabolism. **Results from this study will lay the scientific groundwork for the prescription of resistance and endurance exercise to enhance cardiovascular and metabolic fitness in military eligible women.**

BODY OF THE REPORT:

Subject Selection: We will recruit 104 military eligible, non-pregnant women (18 to 35 yrs) over 4 years. The recruiting goal of 104 individuals takes into account a 20% dropout rate with the goal of having 28 volunteers complete the interventions (endurance, resistance and control). Volunteers will be screened by telephone to ensure that they meet study inclusion criteria and are free of exclusionary criteria. Eligible subjects will be scheduled for a screening visit at which time the study will be explained in detail and a written informed consent will be obtained. A fasting blood profile, a urinalysis, fasting and two hour postprandial glucose and a resting EKG will be obtained.

Criteria for subject inclusion will be: premenopausal and age between 18 to 35 years, a body mass index between 18 and 25 kg/m^2. Exclusion criteria include a history or evidence on physical examination or testing of the following: 1) diabetes; 2) orthopedic limitations or history of pathologic fractures, 3) hypertension (>160/90 mmHg; 4) use of prescription or over the counter medications which could affect glucose metabolism (including insulin and oral hypoglycemic agents), 5) smoking.

Experimental Design. Volunteers will be randomly assigned to a 6-month **endurance, resistance training or control group**. All subjects will be weight stabilized and given dietary advice to consume a diet containing at least 250g of carbohydrate per day prior to testing. Diets will not be changed throughout the program. All tests will be performed during the follicular phase of the menstrual cycle. The testing sequence is described below:

<u>Testing Sequence.</u>

1. Recruiting: Telephone screen and advertising

2. Screening visit (1 day)

(a) Physical exam and history

(b) Graded exercise test

3. Dietary Instruction, Body Weight Stabilization (2 weeks)

(a) Two weeks of dietary instruction for body weight stabilization and adequate carbohydrate intake. Perform test of VO_2 max test during this period to avoid interference of vigorous exercise with other metabolic tests.

4. Overnight Visit to the University of Vermont (1 day)

(a) Administration of Baseline Doubly Labeled Water (afternoon of admission)

(b) Computerized Tomography Scan (afternoon of admission)

(c) Resting Metabolic Rate

(d) Dual Energy x-ray Absorptiometry Scan

(e) Fatty Acid Kinetics

(f) Perform Insulin Clamp

5. Return visit (10 days later)

(a) Urine collections of doubly labeled water

6. Random assignment to Endurance, Resistance or Control group

7. Tests <u>During</u> Exercise Programs

(a) Re-assessment of strength to maintain exercise prescription

8. 6 month Post-testing Period:

(a) Testing sequence is identical as described in 3, 4 and 5 (testing conducted at least 48 h after last exercise session)

<u>METHODS</u>

The **METHODS** section is subdivided into the following categories:
(1) Endurance Training, Resistance Training and Control Group;
(2) Energy Expenditure;
(3) Body Composition and Body Fat Distribution;
(4) Insulin Sensitivity
(5) Fat Metabolism

(1) INTERVENTIONS:

<u>(a) Endurance Training Program</u>

All endurance exercise sessions will be preceded by a 10 min warm-up which will consist of stretching of the major muscle groups and slow walking on a treadmill. The women will exercise three times per week using the Racquets Edge Health and Fitness Center. The training sessions will consist of an individually prescribed duration and intensity. To monitor adherence to prescribed training plan, volunteers will wear the heart rate monitor (Polar Accurex, Polar Electronics Inc.) during each training session. A warm-down will be performed after the treadmill session and will consist of flexibility exercises. Data of individuals will be considered in the statistical analysis who attend at least 80% of all exercise sessions.

The women will be taught to monitor their heart rates. The duration of the exercise will be begin at ~ 20 minutes walk/jogging. By the end of the exercise program, individuals will be jogging approximately 45 to 55 minutes (Table 1). By the end of 6 months of endurance training, volunteers will be expending approximately 600-800 kcal per session, or an additional increase of 2400 to 3200 kcal per week generated by the direct energy cost of the exercise. The quantity of expenditure will be substantial but realistic to perform when an adequate adaptation period is built into the study. Dr. Dvorak (a fellow in Dr. Poehlman's laboratory) and hired personal trainers will supervise the exercise program.

Duration of exercise	Week 1	Week 2	Week 3	Week 4
25'	70%	75%	80%	85%
	Week 5	**Week 6**	**Week 7**	**Week 8**
30'	75%	80%	85%	90%
	Week 9	**Week 10**	**Week 11**	**Week 12**
35'	75%	80%	85%	90%
	Week 13	**Week 14**	**Week 15**	**Week 16**
40'	75%	80%	85%	90%
	Week 17	**Week 18**	**Week 19**	**Week 20**
45'	80%	85%	90%	
	Week 21	**Week 22**	**Week 23**	
50'	80%	85%	90%	
	Week 24	**Week 25**	**Week 26**	
55'	80%	85%	90%	

Table 1. Endurance exercise training program (70% represents the percentage of HR_{max} obtained during the peak oxygen consumption test)

(b) Resistance Training Program

The resistance training program is designed to stimulate optimal gains in muscular size and strength over the 6-month training period. Women will train on three non-consecutive days during the week (e.g., Mon, Wed, Fri). Variation in training will enhance the quality of the exercise stimulus by improving the adherence to the training program and reducing the potential boredom often associated with the use of a redundant resistance training protocol.

Women will be individually instructed in the performance of each exercise and allowed to practice the exercise and strength testing protocol several times prior to initial testing and the start of the training program. Prior to strength testing, two resistance training sessions will be conducted so that women can become familiar with the equipment and proper exercise techniques.

Each training session will include a warm-up of low intensity cycling for 5 min, followed by a 10 min of static stretching of all the major muscle groups used in training. Each exercise session will be individually monitored for optimal progression. The resistance program will consist of the following exercises: 1) Leg press, 2) Bench Press; 3) Leg Extensions; 4) Military Press; 5) Lat Pull Downs; 6) Hamstring Curls; 7) Seated Rows; 8) Triceps Extensions and 9) Biceps Curls. The exercises will provide for a total body resistance training program for all of the major muscle groups of the body. Cybex weight training equipment (located in the Racquets Edge Health and Fitness Center) will be used.

The basic prescription is to perform three sets of ten repetitions for individual lift, with sixty seconds breaks between the sets. In addition, volunteers should exercise to the failure during the last set, more specifically, they should be able to perform at least six but no more than 12 repetitions. When they reach the level of performance so that they can reach 12 repetitions during the last set, the resistance will be increased for the next training session. This will ensure the necessary level of overload for each training session.

Because of the need for test specificity, 1 RM evaluations of certain exercises used in the training program will provide the most direct evaluation of the training gains made over the 6-month period. The 1-RM is defined as the maximum amount of resistance that can be moved through the full range of motion of an exercise for no more than one repetition. To determine the 1 RM, each subject will initially perform 3 to 5 repetitions with the lightest weight possible to be sure proper technique is used. The investigator will then select a weight and ask the subject to perform the lift. Following 3 to 4 minutes of rest, the next heaviest weight will be selected and the attempt will be repeated until the subject cannot complete the full lift. In each case, the investigator will attempt to determine the 1 RM with 6 to 7 trials to prevent localized muscle fatigue. Training will be at approximately 80% of 1 RM. The same number of trials, time between trials and order of exercises will be used before and after training for the 1-RM test. Tests will be administered prior to the start of the training program and twice per month for the first two months (because of the anticipated rapid increase in strength) and once per month thereafter. The following exercise will be evaluated for 1 RM's: leg press, leg extension, bench press, military press, lat pull downs and seated rows.

(c) Control Group

The attention control group will meet as frequently in a group as the exercise intervention groups at the University of Vermont. They will be strongly encouraged to maintain their current level of physical activity and not to engage in any form of endurance or resistance exercise. They will receive similar dietary instruction and social support as the exercise intervention groups. They will participate in all testing and weight stabilization. Following the completion of the study, these women will be provide personalized exercise prescriptions for endurance and resistance training programs.

(2) ENERGY EXPENDITURE

(a) Doubly labeled water (DLW).

To determine the effects of endurance and resistance training on **changes** in daily energy expenditure and physical activity, energy expenditure will be measured during a 10-day period using DLW methodology (32). A baseline urine (10 ml) will be collected and a mixed dose of DLW will be orally administered the afternoon before the first test visit. The doses will be approximately 0.24g of $H_2{}^{18}O$ and 0.22g of ${}^2H_2O$ per kg of estimated total body water. The dose described has been selected to achieve initial and final enrichments that translate, by propagation of error analysis to a theoretical uncertainty in carbon dioxide production rates arising from analytical error of less than 5% (32).

Two urine samples will be collected on the morning after dosing, and another two will be collected on a return visit 10 days later. Samples will be analyzed in triplicate for $H_2{}^{18}O$ and ${}^2H_2O$ enrichments by isotope ratio mass spectrometry at the Biomedical Mass Spectrometry Facility in the

Department of Medicine at the University of Vermont using the CO_2 equilibration technique (36), and the off-line zinc reduction method (37). Total daily energy expenditure will be calculated from doubly labeled water data using equation A6 of Schoeller et al (38). **This technique will provide new information on whether physical activity levels (outside of the exercise programs) change in response to the endurance and resistance exercise programs.**

(b) Resting Metabolic Rate (RMR).

RMR will be assessed after an overnight fast in which volunteers will stay overnight. RMR will be measured for each subject by indirect calorimetry for 45 min, using the ventilated hood technique (39). Energy expenditure will be calculated from the equation of Weir (40). The intraclass correlation and coefficient of variation (CV) for RMR determined using test-retest in 17 volunteers is 0.90 and 4.3%, respectively. **This measurement provides information on whether resting energy requirements change in response to endurance and resistance exercise.**

(c) Physical Activity Energy Expenditure.

The energy expenditure of physical activity will be derived by subtracting RMR, and an estimate for the thermic effect of a meal from total daily energy expenditure (32). A fixed constant of 10% of daily energy expenditure for the thermic response to feeding will be assumed (41). We have chosen not to directly measure the thermic effect of a meal because: 1) its contribution to total daily energy expenditure is small (10% of total daily energy expenditure) (42) and 2) postprandial measurements are long (4 to 6 hr) and of questionable reproducibility (43) and 3) the measurement of postprandial energy expenditure would significantly increase the time commitment for the women. **The change in the level of physical activity is a primary outcome variable because of its large contribution to daily energy expenditure and its relationship to changes in body composition.**

(d) Maximal Aerobic Power (VO_2 max).

VO_2 max will be assessed by a progressive and continuous test to exhaustion on a treadmill. VO_2 max will be considered to have been achieved if two of the following criteria are met: 1) a plateauing of VO_2 when the increase in oxygen consumption during the last minute of the VO_2 max test is <200 ml; 2) a respiratory exchange ratio greater than 1.1; or 3) a heart rate at or above the age-related predicted maximum (220 - age, yr). Test-retest conditions (within 1 week) for VO_2 max for 20 volunteers have yielded an intraclass correlation of 0.94. If these criteria are not met, we will request that the volunteer perform another test of VO_2max. VO_2 max will be assessed every two months to take into account the increases in maximal aerobic power so that exercise prescriptions can be re-evaluated to maintain the desired exercise intensity.

(d) Estimated energy intake.

Self-recorded energy intake will be measured for seven days during the doubly labeled water measurement period. Briefly, volunteers will be provided with record sheets and dietary scales including procedures for reporting intake, estimation of portions, and describing food combinations. The energy content from food diaries will provide a more accurate estimate of food quotient necessary in the calculation from doubly labeled water.

(3) BODY COMPOSITION AND BODY FAT DISTRIBUTION

(a) Dual Energy x-ray Absorptiometry (DEXA)

DEXA uses the exponential attenuation due to absorption by body tissues of photons emitted at two energy levels (40 and 70 keV) to resolve body weight into bone mineral, and lean and fat soft tissue masses. The subject will lie supine on a padded table. All metal objects will be removed. The total dose for a scan is less than 1mSv. A total body scan takes about 30 minutes and provides estimates of the following: bone mineral densities (BMD, g/cm^2), soft-tissue attenuations ratios (Rst-values), fat and lean tissue weights (g), and percent body fat for 9 body regions, as well as total body fat weight, %body fat, fat-free mass and total body mineral weight. The reproducibility for body fat is 1.7% in test-retest conditions in six females. **This technique provides information on whether fat mass, fat-free mass and bone density changes in response to endurance and resistance exercise.**

(b) Computerized tomography (CT).

CT scans are performed on a Siemens Somatom DRH scanner (Erlangen, FRG) using the procedures of Sjostrom et al (44). Briefly, women are examined in the supine position with both arms stretched above their head and single 5 mm, 2 second scans are taken at the abdomen at the level of the umbilicus and the mid-thigh level halfway between the greater trochanter and superior aspect of the patella and greater trochanter. Based on our evaluation of mean attenuation and intersection of adipose muscle tissues of over 400 cross-sections of intra-abdominal adipose tissue, a range of -190 to -30 Hounsfield units (HU) are used to measure cross-sectional area of adipose tissue and 30-80 HU for muscle tissue. Intra-abdominal and subcutaneous fat areas (expressed in cm^2) are measured using an automated computer program which outlines fat with the HU range selected. The coefficient of variation for repeat cross-section analysis of scans among 40 women is less than 2% for adipose tissue. **The technique will provide information on whether the quantity of visceral fat changes in response to resistance and endurance exercise.**

(3) INSULIN SENSITIVITY

The hyperinsulinemic/euglycemic clamp will be used to measure sensitivity to insulin (23). Women will have an intravenous catheter placed in a large antecubital vein for infusion (20% dextrose) and another placed in a retrograde fashion into a dorsal vein with the hand kept in a warming box at 70^{0}C to arterialize venous effluent. Blood samples are drawn from the dorsal hand vein for glucose and insulin determination (every 5 min). Plasma glucose levels are measured (Beckman Instruments, Fullerton, CA) and the rate of glucose infusion adjusted every 5 minutes to maintain the desired level of glycemia. Insulin concentrations will be measured by radioimmunoassay in all samples from an individual (baseline, and post-intervention) in a single assay to minimize interassay variation.

The amount of glucose utilized is an index of insulin sensitivity. **This technique will provide new information on changes in insulin sensitivity in response to endurance and resistance exercise in military-eligible women.**

(4) FAT METABOLISM

i. ^{13}C-palmitate kinetics:

Basal rates of lipolysis and whole body fat oxidation will be assessed as previously described (26). Briefly, a non-primed constant infusion of [1-^{13}C]palmitic acid will be administered for 120 min in the post-absorptive state with simultaneous measurement of resting metabolic rate with indirect calorimetry. Samples for determination of the enrichment of the specific activity of palmitic acid will be taken prior to and at 90, 100, 110, and 120 min after the start of the infusion.

The calculations will be made using the following equations:

i. The rate of appearance of palmitic acid (R_{aP}) with the following formula:

$$R_{aP}\,(\mu mol/kg/min) = IR\,/\,IE$$

where, **IR** is the infusion rate of tracer (μmol/kg/min) and **IE** is the enrichment of substrate in plasma at isotopic equilibrium.

ii. The rate of appearance of free fatty acids (R_{aFFA}) with the following formula:

$$R_{aFFA}\,(\mu mol/kg/min) = R_{aP}\,(C_{FFA}/C_P)$$

where, $\mathbf{C_{FFA}}$ is a concentration of free fatty acids in the blood measured by colorometric assay using kit from Biochemical Diagnostics (Brentwood, NY) and $\mathbf{C_P}$ is the concentration of plasma palmitate measured by gas chromatography-mass spectrometry.

iii. The rate of oxidative disposal (FFA_{ox}) of serum fatty acids will be measured by indirect calorimetry. The rate of fat oxidation (FAT_{ox}) is obtained by dividing fat oxidation calculated with indirect calorimetry by 860 (molecular weight of a typical triglyceride), and multiplying it times three (three fatty acids per mole of triglyceride).

iv. The rate of non-oxidative disposal (FFA_{NOX}) of serum fatty acids (extracellular recycling of fatty acids by the following formula:

$$FFA_{NOX} = R_{aFFA} - FFA_{OX}$$

The coefficient of variation for test-retest measurements is 13% and the intra-class correlation is 0.95 for ten older individuals tested two weeks apart. **This technique will provide information on changes in fatty acid appearance and fat oxidation in response to endurance and resistance exercise programs in military eligible women.**

(5) SAMPLE SIZE CALCULATIONS and DATA ANALYSIS

(1) Sample Size Calculations

We have calculated sample sizes based on hypothesized changes within the endurance and resistance treatment conditions. We present power calculations for hypothesized changes in two variables: 1) total daily energy expenditure and 2) insulin sensitivity. Our sample size calculations are for an alpha level of 0.05 with 80% power. Our recruiting and sample size goals were finally based on the changes anticipated with insulin sensitivity because of the larger sample size required.

We hypothesized that the total daily energy expenditure will be increased by 360 kcal/d for both endurance and resistance training with a standard deviation of 200 kcal/d in women. This increase takes into account the 10% increase in resting metabolic rate (160 kcal/d) (30) and the hypothesized increase of 200 kcal/d in free-living physical activity. We anticipate that endurance exercise will increase physical activity during non-exercising time because: 1) the loss of fat mass will reduce the burden of carrying extra weight and 2) daily physical activities will be performed at a lower percentage of VO_2max. We anticipate that resistance training will increase fat-free mass by 2-3 kg. Data from our laboratory shows that for each 1 kg increase in fat-free mass, resting metabolic rate increases by approximately 50 kcal/d (42). This would translate into a 150-160 increase in resting metabolic rate per day. Again, given the increase in fat-free mass, we anticipate that women will be more physically active and expend approximately 200 kcal/d more per day in their non-exercising time. Thus, we hypothesize that total daily energy expenditure will be increased by an extra 360 kcal/d with a standard deviation of 200 kcal/d (32).

We have also performed power analyses on changes in insulin sensitivity. We estimated that setting the power at 0.80 and a significance level at 0.05, in order to detect a difference in glucose utilization 0.4 mg/kg fat free-mass/min. This preliminary data from our laboratory is based on 0.8 mg/kg fat-free mass change in glucose utilization in 10 endurance trained individuals who trained for 6 months and a 0.4 mg/kg fat-free mass change in 12 older individuals who lost 4 kg after 6 months and with a standard deviation of 1.1 and 1.3 mg, respectively. We will need 85 subjects or 28 women per group (resistance, endurance and control). With a 20% dropout rate, we will need to recruit 104 women over the four year grant period. Because the sample size calculations for this variable yielded the greatest number of subjects to be recruited, we have based our recruiting and sample size calculations on the change in insulin sensitivity.

(b) Statistical Analysis

Analysis: A repeated measures analysis of variance will be used to detect changes with time within the treatment condition and among groups (endurance vs resistance vs control). The repeated measures factor will be the repeated tests during the exercise programs.

This analysis will provide information on whether total daily energy expenditure, resting metabolic rate, physical activity, fat metabolism and intra-abdominal body fat and insulin sensitivity change in response to and among treatment conditions. Changes in the dependent variables will be analyzed on an absolute as well as relative (%) basis.

RESULTS:

See attached paper in Appendix II.

DISCUSSION:

We conclude that our randomization procedure has been successful, as there were not any statistically significant differences among the groups at pre-testing in any of the physical characteristic variables. Moreover, we continue to be successful in recruitment of volunteers. The training proceeds as planned, without any major problems. To date, the dropout rate is ~36% (28 volunteers), which is slightly higher than we have anticipated (20%). The major reason for dropouts has been non-compliance with the training protocol (18 volunteers). That is, the volunteers' participation in the training was below an acceptable level (80%), typically due to conflicts with their other commitments. Furthermore, three volunteers dropped out because of an injury (knee pains, ankle pains). This is to be expected, because only previously sedentary women are accepted for participation. Some of the other reasons included relocation (two volunteers), refusal to return for post-testing (two volunteers), health problems not related to training (one volunteer), and pregnancy (one volunteer). To decrease our dropout rate, we have adopted a strategy of very detailed discussions with each prospective volunteer (by two different members of our team) during the initial contact over the phone as well as during the screening visit. On both occasions, we thoroughly describe and stress the time commitment necessary for their successful participation in the study. This approach has proven successful, during the last six to eight months we have observed a substantially lower dropout rate.

The analysis of the pre- and post-intervention data supported the anticipated effect of our exercise training interventions. The increases in peak oxygen consumption as well as maximum strength and fat-free mass are in accordance with the results of similar exercise intervention studies.

RECOMMENDATIONS:

Recommendations at this time include that a continuous program involving resistance and/or endurance training shows significant improvements in glucose disposal in young women with normal body weight. This type of training also has a long term effect on preventing the onset of type 2 diabetes, hypertension and cardiovascular disease. Each volunteer who has completed this study has seen significant results in their overall health. It has been recommended to them to continue a similar program on their own to further maintain a healthy lifestyle.

KEY RESEARCH ACCOMPLISHMENTS:

- Women with a BMI <26 but with a body fat percentage 30% are at a higher risk for impaired insulin sensitivity, which will potentially promote an early onset of type 2 diabetes, hypertension, and CVD.
- Young non-obese women with both high percentages of subcutaneous and visceral abdominal fat accumulation are at higher risk for impaired insulin sensitivity.
- Recent data has shown that obesity-related phenotypes are present in apparently healthy, young women with normal body weight.
- Major findings include that resistance and endurance training improve glucose disposal which could prevent the onset of metabolic deterioration, type 2 diabetes, and obesity.
- The volume of physical activity preformed in the present study may be more beneficial in preventing increases in total regional fat with advancing age, rather than promoting fat loss.

REPORTABLE OUTCOMES:

Through the course of working on this project, two papers have been submitted for publication. "Phenotypic Characteristics Associated With Insulin Resistance in Metabolically Obese but Normal Weight Young Women" is located in Appendix I. "Effects of Resistance Training and Endurance Training on Insulin Sensitivity in Non-obese, Young Women: A Controlled Randomized Trial" is located in Appendix II. In addition, a strong database of 88 volunteers has been generated from this study. This database will allow us to compare information in this study with current findings in our line of research. A current copy of this database is located in Appendix III.

This grant has provided the University of Vermont with several employment and research opportunities. The Department of Medicine has developed a strong relationship with Racquet's Edge Health and Fitness Center, which has a direct effect on the community. Racquet's Edge is the leader among fitness clubs in this area and will be a strong link for the University of Vermont research department to the community. Employment opportunities from this project have been significant. Dr. Roman Dvorak has been working on this project since the beginning. It has given him the opportunity to become independent with his own research and complete his post doctoral degree here at the University of Vermont. Moreover, Travis Beckett and Kristen Kinaman have had the opportunity to personal train the volunteers as well as to help coordinate scheduling and assist in research for this project. Sarah Goodrich has also helped in training the volunteers at the Racquet's Edge furthering her career in research.

CONCLUSIONS:

We are very pleased with the progress of the study. We were able to recruit a substantial cohort of young women and the composition of all three groups follow the inclusion criteria as outlined above. Moreover, absence of significant difference among the groups at the pre-testing in age, weight, body mass index and peak oxygen consumption indicates that our randomization procedure works as anticipated. We have been receiving positive feedback from volunteers in the exercise training groups. Furthermore, the analysis of pre-versus post-exercise intervention data has shown that our exercise training intervention induced the anticipated effects with respect to peak oxygen consumption, maximum strength, and fat-free mass. Overall, we conclude that every aspect of the study proceeds as proposed in our original application and that we will complete the project in the anticipated time.

REFERENCES:

1. Poehlman, ET, PJ Arciero, MI Goran. Endurance exercise in aging humans: effects on energy metabolism. (Ed) John O Holloszy, Williams and Wilkins, Baltimore, Exercise and Sports Science Reviews: 250-284, 1994.

2. Ravussin E, S Lillioja, WC Knowler, L Christin, D Freymond, WGH Abbott, V Boyce, B Howard, C Bogardus. Reduced rate of energy expenditure as a risk factor for body weight gain. N Eng J Med 318: 467-472, 1988.

3. Arciero, PJ, MI Goran and E.T. Poehlman. Resting metabolic rate is lower in females than males. J. Appl. Physiol 75: 2514-2520, 1993.

4. Gardner AW, ET Poehlman. Physical activity is a significant predictor of body density in women. Am J Clin Nutr 57: 8-14, 1993.

5. Goran MI, ET Poehlman. Endurance training does not enhance total energy expenditure in healthy elderly persons. Am J Physiol 263: E950-E957, 1992.

6. Kokkinos PF, BF Hurley. Strength training and lipoprotein-lipid profiles. Sports Med 9: 266-272, 1990.

7. Campbell WW, MC Crim, VR Young, WJ Evans. Increased energy requirements and body composition changes with resistance training in older adults. Am J Clin Nutr 60: 167-175, 1994.

8. Pratley R, B Nicklas, M Rubin, J Miller, A Smith, B Hurley, A Goldberg. Strength training increases resting metabolic rate and norepinephrine levels in healthy 50- to 65-yr old men. J Appl Physiol 76: 133-137, 1994.

9. Welle S, KS Nair. Relationship of resting metabolic rate to body composition and protein turnover. Am. J. Physiol. 258: E990-998, 1990.

10. Després JP and A Marette. Relation of components of insulin resistance to coronary disease risk. Current Opinion in Lipidology 5: 274-289, 1994.

11. Schwartz RS, WP Shuman, V Larson, DC Cain, Gilbert W Fellingham, JC Beard, SE Kahn, JR Stratton, MD Cerqueira, IB Abrass. The effect of intensive endurance exercise training on body fat distribution in young and older men. Metabolism 40: 545-551, 1991.

12. Tonino RP. Effect of physical training on the insulin resistance of aging. Am J Physiol 256: E352-356, 1989.

13. Houmard JA, C McCulley, LK Roy, RK Bruner, MR McCammon, RG Israel. Effects of exercise training on absolute and relative measurements of regional adiposity. Int J Obesity 18: 243-248, 1994.

14. Kirwan JP, WM Kohrt, DM Wojta, RE Bourey, JO Holloszy. Endurance exercise training reduces glucose-stimulated insulin levels in 60- to 70- year old men and women. J Gerontol 48: M84-M90, 1993.

15. Khort SM, JP Kirwan, MA Staten, RE Bourey, DS King, JO Holloszy. Insulin resistance in aging is related to abdominal obesity. 42: 273-281, 1993.

16. Holloszy JO and HJ Narahara. Studies of tissue permeability. X. Changes in permeability of 3-methyl-glucose associated with contraction of isolated frog muscle. J Biol Chem 240: 3493-3500, 1965.

17. Ross R, J Rissanen. Mobilization of visceral and subcutaneous adipose tissue in response to energy restriction and exercise. Am J Clin Nutr 60: 695-703, 1994.

18. Craig VW, J Everhart, R Brown. The influence of high-resistance training on glucose tolerance in young and elderly subjects. Mech Ageing Dev 75: 147-157, 1989.

19. Smutok MA, C Reece, PF Kokkinos, C Farmer, P Dawson, R Shulman, J DeVane-Bell, P Patterson, C Charabogos, AP Goldberg, BF Hurley. Aerobic versus strength training for risk factor intervention in middle aged-men at high risk for coronary heart disease. Metabolism 42: 177-184, 1993

20. Miller, WJ, WM Sherman, JI Ivy. Effect of strength training on glucose tolerance and post-glucose insulin response. Med Sci Sports Exerc 16: 539-543, 1984

21. Miller JP, RE Pratley, AP Goldberg, P Gordon, M Rubin, MS Treuth, AS Ryan, BF Hurley. Strength training increases insulin action in healthy 50- to 65-yr old men. J Appl Physiol 77: 1122-1127, 1994.

22. Rebuffé-Scrive M, B Andersson, L Olbe, P Bjorntorp. Metabolism of adipose tissue in intraabdominal depots of nonobese men and women. Metabolism 38: 453-458, 1989.

23. DeFronzo RA. The triumvirate: B-cell, muscle, liver: a collusion responsible for NIDDM. Diabetes 37: 667-687, 1988.

24. Crampes F, M Beauville, D Riviere, M Garrigues. Physical training in humans on response of isolated fat cells to epinephrine. J Appl Physiol 61: 25-29 1986.

25. Poehlman ET, A Tremblay, M Marcotte, L Perusse, G Thériault, C Bouchard. Heredity and changes in body composition and adipose tissue metabolism after short-term training. Eur J Appl Physiol 56: 398-402, 1987.

26. Poehlman ET, AW Gardner, PJ Arciero, MI Goran, J Calles-Escandon. Effects of endurance training on total fat oxidation in elderly persons. J Appl Physiol 76: 2281-2287, 1994.

27. Melby C, S Scholl, G Edwards, R Bullough. Effect of acute resistance exercise on postexercise energy expenditure and resting metabolic rate. J Appl Physiol 75: 1847-1853, 1993.

28. Toth MJ, AW Gardner, PJ Arciero, J Calles-Escandon and ET Poehlman. Free fatty acid appearance and fat oxidation in younger and older men. in press, J Appl Physiol

29. Calles-Escandon J, PJ Arciero, AW Gardner, C Bauman and ET Poehlman. Basal fat oxidation with aging in women. J Appl Physiol 78: 266-271, 1995.

30. Poehlman ET, E Danforth Jr. Endurance training increases metabolic rate and norepinephrine appearance in older individuals. Am J Physiol 261: E233-239, 1991.

31. Poehlman ET, AW Gardner, MI Goran. Influence of endurance training on energy intake, norepinephrine kinetics and metabolic rate in older individuals. Metabolism 41: 941-948, 1992.

32. Goran MI, ET Poehlman. Total energy expenditure and energy requirements in healthy elderly persons. Metabolism 41: 744-752, 1992.

33. Toth MJ, ET Poehlman. Resting metabolic rate and cardiovascular disease risk in resistance and aerobic trained middle-aged women. Int J Obesity 19: 691-698, 1995.

34. Smith-Ryan AJ, RE Pratley, AP Goldberg, D Elahi. Increased insulin sensitivity with resistive training is accentuated by weight loss in postmenopausal women. (submitted, J Appl Physiol).

35. National Diabetes Data Group. Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 28: 1039-1057, 1979.

36. Cohn M, HC Urey. Oxygen exchange reactions of organic compounds and water. J Am Chem Soc 60: 679-687, 1938

37. Kendall C, TB Copelan. Multisample conversion of water to hydrogen by zinc for stable isotope determination. Anal Chem 57: 1437-1440, 1985.

38. Schoeller DA, E Ravussin, Y Schutz, KJ Acheson, P Baertschi, E Jéquier. Energy expenditure by doubly labeled water: validation in humans and proposed calculation. Am J Physiol 250:R823-830, 1986.

39. Poehlman ET, TL McAuliffe, DR Van Houten, E Danforth E Jr. Influence of age and endurance training on metabolic rate and hormones in healthy men. Am J Physiol 259: E66-E72, 1990

40. Weir JB de V. New methods for calculating metabolic rate with special reference to protein metabolism. J Physiol 109: 1-9, 1949.

41. Poehlman ET, CL Melby, SF Badylak. Relation of age and physical exercise status on metabolic rate in younger and older healthy men. J Gerontol 46: B54-B58, 1991.

42. Poehlman ET. Energy expenditure and requirements in aging humans. J Nutr 122: 2057-2065, 1992.

43. Westrate JA. Resting metabolic rate and diet-induced thermogenesis: a methodological appraisal. Am J Clin Nutr 58: 592-601, 1993.

44. Sjostrom L, Kvist H, Cederblad A, Tylen U. Determination of total adipose tissue and body fat in women by computed tomography, ^{40}K, and tritium. Am J Physiol 250:E736-E745, 1986.

APPENDIX I

Correct

Measurements

Glucose tolerance. An OGTT was performed in the morning after an overnight fast. A Teflon catheter was placed into an antecubital vein, and baseline samples for the measurement of insulinemia and glycemia were drawn. Thereafter, a standard glucose load (1.33 g/kg of body mass) was given orally (Ensure Plus). Samples for repeated measurement of glycemia and insulinemia were then taken 120 min after baseline.

Body composition. We measured body composition by dual energy X-ray absorptiometry (Lunar DPX-L, Madison, WI), as previously described (4). The subjects were instructed to lay supine on a padded table with all metal objects removed. A total body scan takes ~30 min. This method uses a three-compartment model of body composition and provides an estimate of fat mass, fat-free mass (FFM), and bone mineral density. We analyzed all scans by the Lunar DPX-L extended analysis software, version 1.3. The test-retest reproducibility for body fat is 1.7% (six females) in our laboratory.

Body fat distribution. We measured body fat distribution by computed tomography (CT) using a General Electric High Speed Advantage CT Scanner (GE Medical Systems, Milwaukee, WI), as previously suggested by Sjostrom et al. (5) and reported by our laboratory (6). Visceral and subcutaneous abdominal fat accumulation was assessed at the level of L_4-L_5 intervertebral space. Scan position for the abdominal level was established using a scout view, positioning the scanner within the desired intervertebral space. The scans were 5 mm in thickness and performed at 120 kV and 220 mA. Visceral and subcutaneous adiposity was quantified by delineating the visceral cavity using the trace function and excluding the retroperitoneal area. The boundary was established at the innermost aspects of the abdominal and oblique muscle walls. Subcutaneous adipose tissue was selected as the area remaining between the visceral boundary and the skin. Retroperitoneal fat was excluded from both the subcutaneous and visceral adipose tissue areas. Adipose tissue was selected by the software at an attenuation range of −190 to −30 Hounsfield units. The visceral cavity was assessed using the "mask" function and then the subcutaneous area using the "contour" feature. The same individual analyzed all scans, and the interclass correlation for repeated analysis of 10 scans was 0.99 in 10 women. correct with "H"

Cardiorespiratory fitness. Maximum aerobic capacity (Vo_{2max}) was determined from an incremental exercise test on a treadmill to exhaustion, as previously described (7). After an initial 3-min warm-up, the speed was set so that the heart rate would not exceed 70% of the age-predicted maximum heart rate [220 − age (years)]. Thereafter, the speed was held constant, and the grade was increased by 2.5% every 2 min. The criteria for achieving a Vo_{2max} were *1*) a respiratory exchange ratio > 1.0, *2*) a heart rate at or above the age-predicted maximum, and *3*) no further increase in oxygen consumption with an increasing workload. At least two of these criteria were reached by all volunteers. Test-retest conditions for nine individuals (on two occasions tested 1 week apart) yielded an intraclass correlation of 0.94 and a coefficient of variation of 3.8% in our laboratory.

Physical activity energy expenditure. We used doubly labeled water in combination with indirect calorimetry to measure free-living physical activity energy expenditure (PAEE). Total daily energy expenditure (TEE) was determined over a 10-day period. Each subject was dosed with a 1 g/kg body mass of $^2H_2{}^{18}O$ using the method of Schoeller and van Santen (8), as previously described (9). Briefly, a baseline urine sample was collected before dosing. The following morning, two additional urine samples were collected, and two more samples were collected 10 days later. Urine samples were stored frozen in vacutainers at −20°C until analyzed for ^2H and ^{18}O enrichments by isotope ratio mass spectrometry. ^{18}O isotopic enrichment was determined from the carbon dioxide (CO_2) equilibration technique, and ^2H enrichment was determined by the zinc catalyst method (10). Daily rate of CO_2 production (mol/day) was calculated using the equation of Speakman et al. (11): $rCO_2 = N/2.196 \times ({}^{n}O\,{}^{k}O - {}^{n}H\,{}^{k}H)$, where ^{k}O and ^{k}H are the elimination rates of ^{18}O and ^2H tracers from the body, and ^{n}O and ^{n}H are the dilution spaces for ^{18}O and ^2H tracers, as recommended by Racette et al. (12). Assuming a respiratory quotient of 0.85 for the food consumed (13), total CO_2 production was converted to TEE (kJ/day) using the formula by Weir (14).

Resting metabolic rate (RMR) was determined from 45 min of indirect calorimetry using the ventilated hood technique, as previously described (15). Respiratory gas analysis was performed using a Deltatrac metabolic cart (Sensormedics, Yorba Linda, CA). RMR (kJ/day) was calculated from the equation by Weir (14). Assuming a thermic effect of feeding of 10% (16), total PAEE was then calculated from the equation: PAEE = [(TEE × 0.90) − RMR]. That is, PAEE represents the energy expenditure accumulated above basal levels, which include volitional and nonvolitional activities. We have previously reported an intraclass correlation of 0.90 and a coefficient of variation of 4.3% for the measurement of RMR in 17 older volunteers from two different occasions tested 1 week apart.

Insulin sensitivity. We measured insulin sensitivity by the hyperinsulinemic-euglycemic clamp technique, as proposed by DeFronzo et al. (17). Briefly, a Teflon catheter was inserted into the antecubital vein for the infusions of insulin and dextrose. Another Teflon catheter was retrogradely placed into the dorsal vein of the contralateral hand and used for the blood draws during the clamp procedure. This hand was placed in a "hot box" and warmed to 70°C for arterialization of blood. At time 0 min, a continuous infusion of insulin was started at a constant rate of 240 pmol · m^{-2} · min^{-1}. At the same time, a variable infusion of 20% dextrose was started to maintain fasting glycemia ±5%. Blood samples for glucose measurement were taken every 5 minutes for insulin measurements at −30, −10, 0, 30, 60, 70, 90, 105, and 120 min of the clamp. The insulin levels attained during the last 30 min of the clamp (minute 90–120) were 75 ± 23 μU/ml (mean ± SD). Insulin-stimulated glucose disposal rate (*M* value) was calculated as the average glucose infusion rate (mg/min) during the last 30 min of the 120-min clamp, adjusted for the total distribution volume of glucose (250 ml/kg). Hepatic glucose production has previously been shown to be fully suppressed, with the insulin dose used in our study to induce hyperinsulinemia (18).

Dietary intake. Dietary intake was measured for 3 days (one weekend and two weekdays), as previously described (19). Participants were instructed by a registered dietitian and encouraged to maintain their usual diet. Moreover, they were provided with dietary scales and measuring cups and spoons to further increase precision of obtained data. Diets were analyzed using the Nutritionist III software version 4.0 (N-Squared Computing, Salem, OR).

Blood pressure. Blood pressure was determined during the screening visit at the GCRC using a Dinamap automatic cuff machine (Critikon, Tampa, FL), as previously described (20). Subjects rested in the sitting position for 10 min and then the measurement was taken from their right arm. Appropriate cuff size was selected based on arm circumference.

Biochemical analyses. Plasma glucose concentrations were measured using the glucose oxidase method with an automated glucose analyzer (YSI Instruments, Yellow Springs, OH). Serum insulin was measured by a double antibody radioimmunoassay (Diagnostics Products, Los Angeles, CA). Plasma cholesterol, triglyceride, and HDL cholesterol concentrations were determined from standard enzymatic techniques at the Centers for Disease Control accredited laboratory of the Fletcher Allen Medical Center. Interassay coefficient of variation for the measurement of total and HDL cholesterol was 3.35 and 1.15%, respectively. LDL cholesterol was determined from the equation by Friedewald et al. (21).

Statistical analysis. To identify women classified as having impaired insulin sensitivity, we used a glucose disposal cut-point value of 8.0 mg · min^{-1} · kg^{-1} of FFM, based on previous data (22). Women with a glucose disposal rate greater than the cut-point value were classified as having normal insulin sensitivity and those women with values below the cut point as having impaired insulin sensitivity. The rationale for using glucose disposal as the criterion method to categorize individuals as normal or MONW is based on the notion that resistance to insulin-stimulated glucose uptake is suggested as a common pathogenic mechanism for type 2 diabetes, hypertension, and, ultimately, CVD (23,24). Differences in dependent variables between the groups (MONW vs. normal) were examined using an independent *t* test. Differences between groups in cardiorespiratory fitness were examined using analysis of covariance, with body weight as a covariate (7). Given the unequal sample size between groups, we examined the equality of variances in each variable using Levene's test. When the variances were unequal (HDL cholesterol and glucose disposal adjusted per kilogram of FFM), a *P* value based on Satterthwaite's (25) approximation for the degrees of freedom was used. A χ^2 test was used to compare the differences between the groups for the family history of diabetes and use of oral contraceptives. All values are reported as means ± SD. Significance was accepted at $P < 0.05$. Data were analyzed using the SPSS statistical software (Version 7.5.1, SPSS, Chicago).

5 mg

RESULTS

Table 1 shows glucose disposal values and anthropometric variables for the normal and MONW groups. By design, the MONW women showed a lower absolute and adjusted (per kilogram of FFM) insulin-stimulated glucose disposal rate. The groups were similar with respect to age, BMI, body mass, FFM, and appendicular fat mass. Women classified as MONW, however, showed a greater total fat mass ($P < 0.05$), body fat percentage ($P = 0.01$), truncal fat ($P = 0.02$), and subcutaneous ($P < 0.05$) and visceral ($P < 0.05$) abdominal adiposity than women with normal insulin sensitivity.

We found no differences between groups in cardiorespiratory fitness on an absolute or adjusted basis (Table 2). On the other hand, we found a lower PAEE in the MONW women compared with normal women ($P < 0.001$, Table 2). No differences between groups were found for systolic or diastolic

N= total body water pool.

TABLE 1
Comparison of glucose disposal and anthropometric variables between women with impaired (MONW) and normal insulin sensitivity

Variable value	MONW	Normal	P
n	13	58	—
Age (years)	29 ± 3	28 ± 4	0.97
Glucose disposal (mg/min)	250 ± 65	444 ± 112	0.001
Glucose disposal ($mg \cdot FFM^{-1} \cdot min^{-1}$)	6.5 ± 1.7	11.0 ± 2.2	0.001
BMI (kg/m^2)	22.5 ± 2.0	21.5 ± 2.0	0.08
Body mass (kg)	60.1 ± 8.9	58.4 ± 6.9	0.42
FFM (kg)	38.9 ± 5.1	40.3 ± 4.0	0.28
Fat mass (kg)	18.4 ± 5.2	15.3 ± 4.4	0.03
Body fat (%)	31.8 ± 5.9	27.4 ± 5.5	0.01
Appendicular fat (kg)	8.9 ± 2.6	8.0 ± 2.3	0.23
Truncal fat (kg)	8.2 ± 2.6	6.5 ± 2.4	0.02
$L_{4,5}$ subcutaneous fat area (cm^2)	213 ± 61	160 ± 78	0.03
$L_{4,5}$ visceral fat area (cm^2)	44 ± 16	35 ± 14	0.046

Data are means ± SD. To identify women classified as having impaired insulin sensitivity, we used a glucose disposal cut-point value of 8.0 $mg \cdot min^{-1} \cdot kg^{-1}$ of FFM, based on the data presented by Beck-Nielsen and Groop (22).

blood pressure, family history of diabetes, or the use of oral contraceptives (Table 2). Furthermore, we found no differences in total energy intake (8.28 vs. 8.32 MJ/day); percent intake of carbohydrate (53 vs. 56%), fat (33 vs. 30%), and protein (13 vs. 14%); and percent fat intake from saturated fat (36 vs. 34%) between the MONW and normal group, respectively.

In Table 3, we present the results of the OGTT and serum lipid profile. The MONW group showed a higher fasting (P = 0.03) and 2-h postload insulin ($P < 0.001$), 2-h postload glucose ($P < 0.01$), and total serum cholesterol ($P < 0.01$) than the normal group. We found no differences between groups in fasting serum glucose, HDL cholesterol, total–to–HDL cholesterol ratio, LDL cholesterol, or fasting triglycerides.

DISCUSSION

To our knowledge, this is the first study to comprehensively examine the phenotypic characteristics associated with the MONW syndrome in young women. Based on our approach, we found that 18% of our population was classified as having impaired insulin sensitivity, despite having normal body weight and BMI. Furthermore, young MONW women with impaired insulin sensitivity showed a cluster of risky phenotypic characteristics, including low PAEE and increased total and visceral adiposity.

The incidence of obesity and type 2 diabetes is increasing among women (26), which places them at high risk for the development of insulin resistance and associated comorbidities (27). Given that the deleterious consequences of compensatory hyperinsulinemia (i.e., microangiopathy, hypertension, and CVD) are present at the time of diagnosis of overt type 2 diabetes (28), a clear medical need exists to identify markers for early detection of these individuals before the onset of an established disease process.

We classified individuals above and below a glucose disposal cut point of 8 $ml \cdot min^{-1} \cdot kg^{-1}$ of FFM. The use of glucose disposal to subdivide young women into normal and MONW groups is based on the notion that a decrease in insulin sensitivity may be a common pathogenic mechanism in the development of type 2 diabetes, hypertension, and CVD (23,24). Although this cut point may be considered somewhat arbitrary, women who were classified as having impaired insulin sensitivity (based on hyperinsulinemic-euglycemic clamp) also displayed an altered response to oral glucose load (Table 2). Furthermore, the chosen cut point was based on previous multicenter data (22) that examined insulin sensitivity data from a large sample of individuals. We were somewhat surprised that 18% (n = 13) was categorized as having impaired insulin sensitivity. This finding supports the hypothesis by Ruderman et al. (2) regarding the relatively high prevalence of individuals with impaired insulin sensitivity in apparently healthy normal-weight individuals. This finding prompted us to examine several obesity-related phenotypic characteristics that have been implicated in the development of impaired insulin sensitivity.

In the present study, we found that women with impaired insulin sensitivity were characterized by a higher body fat percentage and fat mass than women with normal insulin sensitivity, despite no difference in body mass or BMI between groups. This suggests that even small increases in body fatness (2–3 kg) within a normal range of BMI negatively affect insulin sensitivity. Indeed, in our cohort, the incidence of impaired insulin sensitivity reached almost 40% among women with a body fat percentage >30%. Therefore,

TABLE 2
Comparison of cardiorespiratory fitness, PAEE, blood pressure, oral contraceptives, and incidence of family history of diabetes between women with impaired (MONW) and normal insulin sensitivity

Variable	MONW	Normal	P value
n	13	58	—
Vo_{2max} (ml/min)	2,228 ± 509	2,297 ± 426	0.61
Adjusted Vo_{2max} (ml/min)*	2,197 ± 396	2,304 ± 395	0.38
PAEE (MJ/day) (n)	2.66 ± 0.92 (9)	4.39 ± 1.50 (41)	0.01
Systolic blood pressure (mmHg)	118 ± 12	118 ± 14	0.99
Diastolic blood pressure (mmHg)	69 ± 8	68 ± 10	0.73
Family history of diabetes (%) (yes/no)	31 (4/9)	32 (14/44)	0.53
Use of oral contraceptives (%) (yes/no)	60 (8/5)	47 (27/31)	0.33

Data are means ± SD or %. *Adjusted for kilogram of body weight, as previously described (7).

TABLE 3
Comparison of OGTT and blood lipid values between women with impaired (MONW) and normal insulin sensitivity

Variable	MONW	Normal	P value
n	13	58	—
Fasting glucose (mmol/l)	4.4 ± 0.4	4.4 ± 0.3	0.80
2-h postload glucose (mmol/l)	5.7 ± 1.1	4.6 ± 1.1	0.003
Fasting insulin (pmol/l)	60 ± 20	49 ± 15	0.03
2-h postload insulin (pmol/l)	481 ± 259	281 ± 186	0.001
Total cholesterol (mmol/l)	5.3 ± 0.9	4.5 ± 0.7	0.003
HDL cholesterol (mmol/l)	1.7 ± 0.5	1.5 ± 0.3	0.15
Total-to-HDL cholesterol	3.3 ± 0.9	3.3 ± 0.8	0.91
LDL cholesterol (mmol/l)	3.1 ± 0.9	2.7 ± 0.8	0.14
Triglycerides (mmol/l)	2.4 ± 0.7	2.4 ± 1.0	0.93

Data are means ± SD.

we suggest that young women with a BMI <26 but with a body fat percentage >30% are probably at a higher risk for impaired insulin sensitivity and a potentially early onset of type 2 diabetes, hypertension, and CVD. Our findings thus support the notion that BMI is a poor marker to identify women at risk for the development of insulin resistance and associated comorbidities.

The question as to whether body fat topography is "pathogenic" with respect to insulin sensitivity and type 2 diabetes is controversial (29). For example, some investigators found that abdominal subcutaneous adiposity is a stronger predictor of insulin sensitivity than visceral adiposity in middle-aged men and women (30) and in pre-menopausal women (31). On the other hand, others (32,33) reported that visceral adiposity is the stronger determinant of insulin sensitivity in obese women. In the present investigation, young women with impaired insulin sensitivity showed significantly higher subcutaneous as well as visceral abdominal fat accumulation than women with normal insulin sensitivity. Despite the fact that the levels of visceral fat accumulation in the MONW group were well below the suggested critical threshold of 130 cm^2 (34), it is possible that even relatively low levels of visceral adiposity in the presence of higher levels of total body fatness have a deleterious impact on insulin sensitivity. Nonetheless, our findings suggest that in young nonobese women, both subcutaneous and visceral abdominal fat accumulation may be associated with impaired insulin sensitivity.

Physical inactivity (35) and low cardiorespiratory fitness (36) have been implicated as important risk factors in the pathogenesis of type 2 diabetes. We found no differences in cardiorespiratory fitness between groups. This may be because only sedentary women were recruited for the study and thus limited our ability to find differences between the groups. On the other hand, we noted a significantly lower PAEE in the MONW group. To our knowledge, this is the first study that used a direct measurement of PAEE by the doubly labeled water methodology in the examination of risk factors for insulin resistance and CVD in free-living individuals. Previous investigations have reported an inverse relationship between physical activity and incidence of type 2 diabetes (37); however, physical activity levels were only estimated from a self-reported questionnaire, which has been shown to be inaccurate (38). These results suggest that PAEE, and not cardiorespiratory fitness, may be a more important predictor of impaired insulin sensitivity. We would suggest that PAEE probably influences insulin sensitivity and other CVD risk factors primarily through its effects on energy balance and body composition (39). That is, lower levels of PAEE found in the MONW group may favor a positive energy balance, especially because total daily energy intake was similar between the groups. Thus, low levels of PAEE may favor a greater increase in total and central adiposity in susceptible individuals (40).

Despite differences in other phenotypic characteristics between the MONW and normal groups, no differences were found in the total-to-HDL cholesterol ratio, fasting triglycerides, and LDL cholesterol. The cardioprotective effects of estrogen on plasma lipids has been well documented (41). Thus, it is possible that the presence of estrogen in these young women may exert a stronger influence on plasma lipids than differences in physical activity and adiposity.

Our results have clinical implications for the detection and treatment of susceptible individuals for type 2 diabetes and CVD. The phenotypic features associated with impaired insulin sensitivity (increased body adiposity and low levels of physical activity) are generally responsive to lifestyle modifications such as dietary restriction and aerobic exercise training (39,42). Therefore, identification and early treatment of these individuals, particularly at younger ages before metabolic diseases become overt and established, would have a substantial public health value. It needs to be emphasized, however, that our cross-sectional study cannot establish a causative relationship. Further studies using exercise, dietary, or pharmacological interventions are needed to evaluate whether the metabolic profile of MONW individuals can be normalized.

In conclusion, we found that despite a normal body weight, a subset of young, apparently healthy women displayed a cluster of risky phenotypic characteristics that may eventually predispose them to type 2 diabetes and CVD.

ACKNOWLEDGMENTS

This work was supported by the GCRC (RR-00109) from the University of Vermont; a fellowship from the American Heart Association, Maine/New Hampshire/Vermont Affiliate (to R.V.D.); grant no. R01-AG15114 (to P.A.A.); and a grant from the Department of Defense (DE 950226) (to E.T.P.).

We would like to extend our gratitude to all participants in this study. Furthermore, the expert technical help of the staff at the GCRC is greatly appreciated. We would also like to thank Denise DeFalco-McGeein, RNC, NP, for help with physical examinations of patients. Appreciation is also extended to Ethan A.H. Sims, MD, for thoughtful discussions on this topic.

REFERENCES

1. Ruderman NB, Schneider SH, Berchtold P: The "metabolically-obese," normal-weight individual. *Am J Clin Nutr* 34:1617–1621, 1981
2. Ruderman N, Chisholm D, Pi-Sunyer X, Schneider S: The metabolically obese, normal-weight individual revisited. *Diabetes* 47:699–713, 1998
3. Hollenbeck C, Reaven GM: Variations in insulin-stimulated glucose uptake in healthy individuals with normal glucose tolerance. *J Clin Endocrinol Metab* 64:1169–1173, 1987
4. Dvorak RV, Poehlman ET: Appendicular skeletal muscle mass, physical activity, and cognitive status in patients with Alzheimer's disease. *Neurology* 51:1386–1390, 1998
5. Sjostrom L, Kvist H, Cederblad A, Tylen U: Determination of total adipose tis-

sue and body fat in women by computed tomography, 40K, and tritium. *Am J Physiol* 250:E736–E745, 1986

6. Garcia-Rubi E, Starling RD, Tchernof A, Matthews DE, Walston JD, Shuldiner AR, Silver K, Poehlman ET, Calles-Escandon J: Trp[64]Arg variant of the β_3-adrenoceptor and insulin resistance in obese postmenopausal women. *J Clin Endocrinol Metab* 83:4002–4006, 1999
7. Toth MJ, Goran MI, Ades PA, Howard DB, Poehlman ET: Examination of data normalization procedures for expressing peak VO2 data. *J Appl Physiol* 93:2288–2292, 1993
8. Schoeller DA, van Santen E: Measurement of energy expenditure in humans by doubly labeled water method. *J Appl Physiol* 53:955–959, 1982
9. Poehlman ET, Toth MJ, Goran MI, Carpenter WH, Newhouse P, Rosen CJ: Daily energy expenditure in free-living non-institutionalized Alzheimer's patients: a doubly labeled water study. *Neurology* 48:997–1002, 1997
10. Wong WW, Lee LS, Klein PD: Deuterium and oxygen-18 measurement on microliter samples of urine, plasma, saliva, and human milk. *Am J Clin Nutr* 45:905–913, 1987
11. Speakman JR, Nair KS, Goran MI: Revised equation for calculating CO_2 production from doubly labeled water in humans. *Am J Physiol* 264:E912–E917, 1993
12. Racette SB, Schoeller DA, Luke AH, Shay K, Hnilicka J, Kushner RF: Relative dilution spaces of ^{2}H to O_{18} labeled water in humans. *Am J Physiol* 267:E585–E590, 1994
13. Black AE, Prentice AM, Coward WA: Use of food quotients to predict respiratory quotients for the doubly-labelled water method of measuring energy expenditure. *Hum Nutr Clin Nutr* 40:381–391, 1986
14. Weir JB: New methods for calculating metabolic rate with special reference to protein metabolism. *J Physiol Lond* 109:1–9, 1949
15. Donaldson KE, Carpenter WH, Toth MJ, Goran MI, Newhouse P, Poehlman ET: No evidence for a higher resting metabolic rate in noninstitutionalized Alzheimer's disease patients. *J Am Ger Soc* 44:1232–1234, 1996
16. Poehlman ET, Melby CL, Badylak SF: Relation of age and physical exercise status on metabolic rate in younger and older healthy men. *J Geront* 46:B54–B58, 1991
17. DeFronzo RA, Tobin JD, Andres R: Glucose clamp technique: a method for quantifying insulin secretion and resistance. *Am J Physiol* 237:E214–E223, 1979
18. DeFronzo RA: Glucose intolerance and aging: evidence for tissue insensitivity to insulin. *Diabetes* 28:1095–1101, 1979
19. Poehlman ET, Viers HF, Detzer M: Influence of physical activity and dietary restraint on resting energy expenditure in young nonobese females. *Can J Physiol Pharmacol* 69:320–326, 1991
20. Webb GD, Toth MJ, Poehlman ET: Influence of physiological factors on the age-related increase in blood pressure in healthy men. *Exp Gerontol* 31:341–350, 1996
21. Friedewald WT, Levy RI, Fredrickson DS: Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* 18:499–502, 1972
22. Beck-Nielsen H, Groop LC: Metabolic and genetic characterization of prediabetic states: sequence of events leading to non-insulin-dependent diabetes mellitus. *J Clin Invest* 94:1714–1721, 1994
23. Zavaroni I, Bonora E, Pagliara M, Dall'Aglio E, Luchetti L, Buonanno, Bonati PA, Bergonzani M, Gnudi L, Passeri M: Risk factors for coronary artery disease in healthy persons with hyperinsulinemia and normal glucose tolerance. *N Engl J Med* 320:702–706, 1989
24. Reaven GM, Lithell H, Landsberg L: Hypertension and associated metabolic abnormalities: the role of insulin resistance and the sympathoadrenal system. *N Engl J Med* 334:374–381, 1996
25. Satterthwaite FW: An approximate distribution of estimates of variance components. *Biometrics Bulletin* 2:110–114, 1946
26. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL: Increasing prevalence of overweight among US adults: the National Health and Nutrition Examination Surveys, 1960 to 1991. *JAMA* 272:205–211, 1994
27. The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care* 22:S5–S19, 1999
28. Uusitupa MI, Niskanen LK, Siitonen O, Voutilainen E, Pyorala K: 5-year incidence of atherosclerotic vascular disease in relation to general risk factors, insulin level, and abnormalities in lipoprotein composition in non-insulin-dependent diabetic and nondiabetic subjects. *Circulation* 82:27–36, 1990
29. Seidell JC, Bouchard C: Visceral fat in relation to health: is it a major culprit of simply an innocent bystander? *Int J Obes* 21:626–631, 1997
30. Goodpaster BH, Thaete FL, Simoneau JA, Kelley DE: Subcutaneous abdominal fat and thigh muscle composition predict insulin sensitivity independently of visceral fat. *Diabetes* 46:1579–1585, 1997
31. Bonora E, Del Prato S, Bonadonna RC, Gulli G, Solini A, Shank ML, Ghiatas AA, Lancaster JL, Kilcoyne RF, Alyassin AM: Total body fat content and fat topography are associated differently with in vivo glucose metabolism in nonobese and obese nondiabetic women. *Diabetes* 41:1151–1159, 1992
32. Carey DG, Jenkins AB, Campbell LV, Freund J, Chisholm DJ: Abdominal fat and insulin resistance in normal and overweight women: direct measurements reveal a strong relationship in subjects at both low and high risk of NIDDM. *Diabetes* 45:633–638, 1996
33. Ross R, Fortier L, Hudson R: Separate associations between visceral and subcutaneous adipose tissue distribution, insulin and glucose levels in obese women. *Diabetes Care* 96:1404–1411, 1996
34. Despres JP, Lamarche: Effects of diet and physical activity on adiposity and body fat distribution: implications for the prevention of cardiovascular disease. *Nutr Res Rev* 6:137–159, 1993 Lamarche B
35. American Diabetes Association: Screening for type 2 diabetes (Position Statement). *Diabetes Care* 22 (Suppl. 1):S20–S23, 1999
36. Nyholm B, Mengel A, Nielsen S, Skjaerbaek C, Moller N, Alberti KG, Schmitz O: Insulin resistance in relatives of NIDDM patients: the role of physical fitness and muscle metabolism. *Diabetologia* 39:813–822, 1996
37. Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS Jr: Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* 325:147–152, 1991
38. Starling RD, Matthews DE, Ades PA, Poehlman ET: Assessment of physical activity in older individuals: a doubly labeled water study. *J Appl Physiol* 86:2090–2096, 1999
39. Katzel LI, Bleecker ER, Colman EG, Rogus EM, Sorkin JD, Goldberg AP: Effects of weight loss vs aerobic exercise training on risk factors for coronary disease in healthy, obese, middle-aged and older men: a randomized controlled trial. *JAMA* 274:1915–1921, 1995
40. Poehlman ET, Toth MJ, Bunyard LB, Gardner AW, Donaldson KE, Colman E, Fonong T, Ades PA: Physiological predictors of increasing total and central adiposity in aging men and women. *Arch Intern Med* 155:2443–2448, 1995
41. Mendelsohn ME, Karas RH: The protective effect of estrogen on the cardiovascular system. *N Engl J Med* 340:1801–1811, 1999
42. Bogardus C, Ravussin E, Robbins DC, Wolfe RR, Horton ES, Sims EA: Effects of physical training and diet therapy on carbohydrate metabolism in patients with glucose intolerance and non-insulin-dependent diabetes mellitus. *Diabetes* 33:311–318, 1984

Appendix II

SUBMITTED: JCLIN ENDOCRINOL METAB

Title: Effects of Resistance Training and Endurance Training on Insulin Sensitivity in Nonobese,Young Women: A Controlled Randomized Trial

Authors: Eric T Poehlman, Roman V Dvorak, Walter DeNino, Martin Brochu, Philip A Ades

Affiliations: Divisions of Clinical Pharmacology and Metabolic Research and Cardiology, Department of Medicine, College of Medicine, University of Vermont, Burlington, Vermont 05405

Address correspondence and reprint requests to:

Dr Eric T Poehlman

Department of Medicine

Given C-247, University of Vermont

Burlington, VT 05405

802.656.2667

802.656.0883

E-mail: epoehlman@zoo.uvm.edu

Running Head: Exercise and Insulin Sensitivity in Women

ABSTRACT

Insulin resistance is linked with physical inactivity, increased visceral fat and alterations in skeletal muscle characteristics. Preventive interventions to improve the metabolic profile, such as aerobic and resistance training in younger women, thus have significant public health interest. We examined the effects of a six-month randomized program of endurance training (n=14), resistance training (n=17) or control conditions (n=20) on insulin sensitivity in nonobese, younger women (18 to 35 yr). To examine possible mechanism(s) related to alterations in insulin sensitivity, we measured body composition, regional adiposity, and skeletal muscle characteristics with computed tomography. We observed no changes in total body fat, subcutaneous abdominal adipose tissue, nor visceral adipose tissue with endurance or resistance training. Insulin sensitivity, however, increased with endurance training (pre: 421 ± 107 vs post: 490 ± 133 mg/min; $P<0.05$) and resistance training (pre: 382 ± 87 vs post: 417 ± 89 mg/min; $P=0.06$), but not in controls (pre: 470 ± 139 vs post: 480 ± 168 mg/min). When glucose disposal date were expressed per kg fat-free mass, the improved insulin sensitivity persisted in endurance trained (pre: 10.5 ± 2.7 vs post: 12.1 ± 3.3 mg min /kg FFM; $P<0.05$), but not in resistance trained women (pre: 9.7 ± 1.9 vs post: 10.2 ± 1.8 mg min /kg FFM; NS) women. Muscle attenuation ratios increased ($P<0.05$) in both endurance and resistance trained individuals, but this was not related to changes in insulin sensitivity. Moreover, the change in insulin sensitivity was not related to the increased VO_2max in endurance trained women ($r=0.24$;NS). We suggest that both endurance and resistance training improve glucose disposal, although by different mechanisms in young women. An increase in the amount of fat-free mass from resistance training contributes to increased glucose disposal probably from a "mass effect", without altering the intrinsic capacity of the muscle to respond to insulin. On the other hand , endurance training enhances glucose disposal independent of changes in fat-free mass or VO_2max, suggestive of an intrinsic change in the muscle to metabolize glucose. We conclude that enhanced glucose uptake after physical training in young women occurs with and without changes in fat-free mass and body composition. **Key Words: Exercise, insulin sensitivity, visceral fat, body composition**

INTRODUCTION

Aerobic exercise training can improve insulin sensitivity (1-4), whereas the role of resistance training to improve the metabolic profile has received less attention. Since isometric contractions produce insulin-like effects on glucose uptake in isolated skeletal muscle (5) and skeletal muscle is the primary site of glucose disposal at euglycemia, it is reasonable to hypothesize that increasing skeletal muscle may be an effective intervention to improve insulin sensitivity. There is a little information on the effects of resistance training on glucose disposal using clamp methodology in a controlled, randomized design. Moreover, investigators have tended to rely on non-randomized studies and the use of oral glucose tolerance tests to estimate insulin sensitivity (6-9).

To our knowledge, no study has directly compared the effects of endurance vs resistance training on insulin sensitivity using clamp methodology. This omission is surprising given the reported gender differences in insulin sensitivity (10). Moreover, recent data show that despite having a normal body weight, a subset of young women show a cluster of metabolic abnormalities that would predispose them to non-insulin diabetes mellitus, if left untreated (11). The incidence of obesity and type 2 diabetes is increasing among women (12), which places them at high risk for the development of insulin resistance and associated co-morbidities (13,14). Clearly, preventive public health measures to prevent the deterioration in the metabolic profile of younger women are needed before disease processes become established.

To address this topic, we directly compared the effects of resistance training and aerobic training on insulin sensitivity using a controlled randomized trial. Moreover, to examine potential mechanism(s) regulating training effects on insulin sensitivity, we measured changes in body composition, visceral fat and skeletal muscle density using radiologic imaging techniques, as changes in these variables are thought to be related to altered glucose disposal (15-19). We hypothesized that endurance training would increase insulin sensitivity to a greater degree than resistance training in young women, due to greater reductions in intra-abdominal fat and increased skeletal muscle density.

METHODS

Criteria for subject inclusion were: premenopausal and age between 18 to 35 years; a body mass index less than 26. In addition, subjects had to be weight stable (±2kg) over 6 months preceding the study; no regular participation in exercise for six months prior to study. Exclusion criteria included a history or evidence on physical examination or testing of the following: 1) diabetes; 2) orthopedic limitations or history of pathologic fractures, 3) hypertension (>160/90 mmHg; 4) use of prescription or over-the-counter medications which could affect glucose metabolism (including insulin and oral hypoglycemic agents), 5) smoking; 6) alcohol consumption greater than 15g of alcohol/day. An oral glucose tolerance test (OGTT) was performed in all volunteers to determine glucose tolerance according to the criteria of the National Diabetes Group (13) to exclude diabetics. This study was approved by the Committee for Human Research at the University of Vermont and each participant gave their written, informed consent prior to the beginning of the study.

Overview of Experimental Protocol: Subjects were recruited from local newspaper advertisements in the Burlington, Vermont and the University of Vermont community. After determination of eligibility by telephone, volunteers were scheduled for the first screening visit. On the screening visit, an oral glucose tolerance test, medical history, physical examination, maximum oxygen consumption test and complete blood chemistry and profile were performed. Two weeks later, participants were scheduled for an overnight visit to the General Clinical Research Center (GCRC) at the University of Vermont. For three days prior to the overnight visit, participants were provided with standardized diets prepared by the metabolic kitchen at the GCRC containing 55% carbohydrate, 25% fat and 20% protein. During the afternoon of admission, we conducted body composition and body fat distribution measurements using dual energy x-ray absorptiometry and computed tomography. The following morning, the hyperinsulinemic-euglycemic clamp was performed. Following successful completion of this testing sequence, volunteers were randomly assigned to endurance exercise, resistance exercise or control. An identical post-testing sequence was performed and these tests were performed six days after the last exercise session.

Recruiting and Screening: Based on our advertisements, 321 women were interviewed by telephone. Of these 321 women, 105 women consented to participate in screening procedures. Of these 105 women, 78 were deemed eligible and consented to participate in pre-training testing procedures. Of these 78 women, 74 were Caucasian, 2 of Asian descent and 2 of Hispanic origin. They were randomized to either endurance training, resistance training or control conditions following completion of physiological testing. During the conduct of the training programs, 28 women dropped out of the study, yielding a dropout rate of 36%. The reasons for dropouts included: 1) non-compliance with training (n=18); 2) relocation (n=3); 3) injury related to endurance training (n=3); 4) refused post-testing (n=2;) 5) health problems not related to training (n=1) and 6) pregnancy (n=1). Thus, 51 women (17 resistance; 14 endurance and 20 control) satisfactorily completed all pre-and post-testing procedures and the six-month training program. The exercising women successfully completed 90% of all exercise training sessions. Oral contraceptive use was 47% in resistance trained (8/17); 50% in endurance trained (7/14) and 50% in controls (10/20).

Exercise Training Programs. All endurance exercise sessions were preceded by a 10 min warm-up which consisted of stretching of the major muscle groups and slow walking around the track. The women exercised three times per week at the Racquet's Edge Health Club Facility under the supervision of a personal trainer. The endurance exercise training group began their training by walk/jogging at approximately 70% of maximum heart rate for 25 minutes each session 3 times per week. The exercise intensity was increased by 5% every week. Thus, by the sixth month, individuals were jogging at approximately 75% to 90% of maximum heart rate for 45 to 60 minutes at an individually prescribed heart rate. All women were taught to monitor their heart rates. Heart rates were verified with a Polar Heart Rate monitor (Polar Electro, Port Washington, NY).

Women resistance trained on three non-consecutive days during the week (e.g., Mon, Wed, Fri) under the supervision of a personal trained. Prior to strength testing, two to three resistance training sessions were conducted so that women could become familiar with the equipment and proper exercise techniques. This period helped control for the inflated gains in strength measurements that usually occur during the initial phase of training due to motor learning. Because of the need for test specificity, 1 RM evaluations of certain exercises used in the training program provided the most direct evaluation of the training gains made over the 6-month period. The 1-RM is defined as the maximum amount of resistance that can be moved through the full range of motion of an exercise for no more than one repetition. To determine the 1 RM, each subject initially performed 3 to 5 repetitions with the lightest weight possible to be sure proper technique is used. The trainer then selected a weight and asked the subject to perform the lift. Following 3-4 minutes of rest, the next heaviest weight was selected and the attempt was repeated until the subject could not complete the full lift. The same number of trials, time between trials and order of exercises were used before and after training for the 1-RM test. Tests were administered prior to the start of the training program, midway through the program and after the exercise program. The following exercises were evaluated for 1 RM's: leg press, bench press, military press and seated rows

Training was approximately 80% of 1 RM. Each training session included a warm-up of low intensity cycling for 5 min, followed by a 10 min of static stretching of all the major muscle groups used in training. Each exercise session was individually monitored for optimal progression by two trainers. The resistance program consisted of the following exercises: 1) leg press, 2) bench press; 3) leg extensions; 4) shoulder press; 5) situps; 6) seated rows; 7) tricep extensions, 8) arm curls and 9) leg curls. The exercises provided a total body resistance training program for all of the major muscle groups of the body. The volunteer was given a target load range and attempted to keep each set within the target range by adjusting the load to allow the prescribed number (n=10) of repetitions. A training zone for the number of repetitions was given to help the investigator and the subject better estimate the load required. Variation in the exercise load was achieved by the prescription of different repetition maximum (RM) ranges for various exercises over the week. Resting periods were 1-1.5 minutes between sets.

Body composition and adipose tissue distribution. Fat mass and fat-free mass were measured by dual energy x-ray absorptiometry (DEXA) using a Lunar DPX-L densitometer (Lunar Co, Madison, WI) as previously described (20). All scans were analyzed using the Lunar Version 1.3 DPX-L extended-analysis program for body composition. Test-retest coefficient of variation for this measurement was 1.2% for fat mass and 2% for fat-free mass, respectively.

Intra-abdominal and abdominal subcutaneous adipose tissue areas were measured by computed tomography with a GE High Speed Advantage CT scanner (General Electric Medical Systems, Milwaukee, WI) as previously described (20). Subjects were examined in the supine position with both arms stretched above the head. The scan was performed at the L4-L5 vertebrae level using a scout image of the body to establish the precise scanning position. Intra-abdominal adipose tissue area was quantified by delineating the intra-abdominal cavity at the internal most aspect of the abdominal and oblique muscle walls surrounding the cavity and the posterior aspect of the vertebral body, with the computer interface of the scanner. Adipose tissue was highlighted and computed using an attenuation range from -190 to -30 Hounsfield Units. The subcutaneous adipose tissue area was quantified by highlighting adipose tissue located between the skin and the external most aspect of the abdominal muscle wall. The same individual analyzed all scans and the interclass correlation for repeated analysis of 10 scans was 0.99 in 10 women. Computed tomography was also used to measure cross-sectional areas of mid-thigh muscle and adipose tissue and to characterize muscle attenuation. With the subject supine, a 5-mm cross-sectional scan of both legs was obtained, located at the midpoint between the anterior iliac crest and top of the patella. In image analysis, areas of adipose tissue and skeletal muscle were measured by selecting the following region of interest defined by attenuation values: ≥200 Hounsfield units (HU) for bone, -30 to -190 HU for adipose tissue, and 0 to 100 HU for muscle; mean muscle attenuation was determined from all pixels within this range.

Cardiorespiratory fitness. Maximum aerobic capacity (VO_{2max}) was determined from an incremental exercise test on a treadmill to volitional exhaustion, as previously described (21,22). After an initial 3-minute warm-up, the speed was held constant and the grade was increased by 2.5% every 2 minutes. The criteria for achieving a VO_{2max} were: a respiratory exchange ratio greater than 1.0; 2) a heart rate at or above the age-predicted maximum; and 3) no further increase in oxygen consumption with an increasing workload. At least two of these criteria were met by all volunteers. Test-retest conditions for 9 individuals (on two occasions tested one week apart) yielded an intra-class correlation of 0.94 and a CV of 3.8% in our laboratory.

Insulin Sensitivity. We measured insulin sensitivity by the hyperinsulinemic-euglycemic clamp technique as described by DeFronzo et al (25) and as previously reported in our laboratory (11,26). Briefly, a teflon catheter was inserted into the antecubital vein for the infusions of insulin and dextrose. Another teflon catheter was retrogradely placed into the dorsal vein of the contralateral hand and used for the blood draws during the clamp procedure. This hand was placed in a "hot box" and warmed to 50°C for arterialization of blood. At time 0', a continuous infusion of insulin was started at a constant rate of 40mU • m^2 body surface area per min. At the same time, a variable infusion of 20% dextrose was started to maintain fasting glycemia ± 5%. Blood samples for glucose measurement were taken every five minutes, for insulin measurement at -30, -10, 0, 30, 60, 70, 90, 105 and 120 minutes of the clamp. The insulin levels attained during the last 30 minutes of the clamp (minute 90 to 120) prior to training were 75 ± 23μU/ml in endurance trained; 74 ± 21μU/ml in resistance trained and 76 ± 20 μU/ml in controls (NS). After training, insulin levels were 76 ± 28μU/ml in endurance trained; 72 ± 22 μU/ml in resistance trained and 77 ± 26 μU/ml and 75 ± 23 μU/ml in control (mean ± SD). Insulin stimulated glucose disposal rate (M-value) was calculated as the average glucose infusion rate (mg/min) during the last 30 minutes of the 120 minute clamp. Hepatic glucose production has previously been shown to be fully suppressed with the insulin dose used in our study to induce hyperinsulinemia (27).

Biochemical Analyses. Plasma glucose concentrations were measured using the glucose oxidase method with an automated glucose analyzer (YSI Instruments, Yellow Springs, OH). Serum insulin was measured by a double antibody RIA (Diagnostics Products Corporation, Los Angeles, CA). The coefficient of variation for repeat determinations is < 5%.

Statistical Analysis: Differences in physical characteristics among groups at baseline were examined using a one-way analysis of variance. A 2 x 3 repeated measures analysis of variance was used to detect changes with time within the treatment condition (pre/post) and among groups (endurance vs resistance vs control). The repeated measures factor was the repeated tests during the exercise programs. Regression analysis was used to determine the relationships between variables. Significance was accepted at $P<0.05$.

RESULTS

Table 1 shows physical characteristics for endurance training, resistance training and control subjects before and after training. There were no differences among the three groups for baseline physical characteristics, suggesting a successful randomization. As expected, endurance trained individuals increased their absolute VO_2max by 29% ($P<0.01$), whereas no changes were noted in resistance trained and control subjects. Similar results were obtained when VO_2max data were expressed per kilogram of body weight. Body weight and body mass index increased in resistance trained individuals (both $P<0.05$) relative to the other two groups. Fat mass, as measured from DEXA, showed no change in endurance trained, resistance trained or controls. Fat free mass showed no change in endurance trained women or controls, but increased in resistance trained women (2 kg; $P<0.001$). As expected, resistance trained individuals increased their 1-repetition maximum for leg press (29%), bench press (39%), military press (29%) and seated rows (27%) (data not shown in table form).

Table 2 shows physical characteristics in women who failed to complete the study. We attempted to identify characteristics that may predict the reasons for dropping out of the study. We found no differences in baseline characteristics between women who failed to complete the study compared to those who completed all testing and exercise training. Interestingly, 23 women out of the 28 total drop-outs were in the endurance training group; the group with highest rate of injuries and noncompliance.

Figure 1 shows pre-and post training values for absolute values of insulin sensitivity and indexed per kilogram of fat-free mass. We noted an increase in both endurance trained (Pre: 421 ± 107 vs Post: 490 ± 133 mg/min; $P<0.05$) and resistance trained women (Pre: 382 ± 87 vs Post: 417 ± 89 mg/min; $P=0.06$)), with no change in controls (Pre: 470 ± 139 vs Post: 480 ± 168 mg/min). When data were expressed per kilogram of fat-free mass, the improvement in glucose disposal persisted in endurance trained women (Pre: 10.5 ± 2.7 vs Post: 12.1 ± 3.3 mg min/kg FFM; $P<0.05$), whereas no significant change was noted in resistance trained (Pre: 9.7 ± 1.9 vs 10.2 ± 1.8 mg min/kg FFM) and controls (11.4 ± 2.8 vs Post: 11.8 ± 3.5 mg min/kg FFM). The improvement in VO_2 max was not related ($r=0.02$; NS) to increased insulin sensitivity in the endurance-trained group.

Table 3 shows changes in abdominal adiposity, thigh adipose and lean tissue content in our cohort before and after training. As expected for non-obese young women, baseline areas of subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT) were relatively low. No significant changes were noted in subcutaneous (SAT) or visceral adipose tissue (VAT) in any group, as measured from computed tomography. Skeletal muscle characteristics, as estimated from computed tomography, are also shown in **Table 3**. We estimated quantities of mid-thigh fat area, thigh muscle area and muscle attenuation values because of their reported relationship with insulin sensitivity (15,16). Mid-thigh fat and thigh muscle area did not change in response to endurance or resistance training. On the other hand, we noted an altered composition in CT imaging, in terms of higher mean values for attenuations values (HU) for both endurance ($P<0.05$) and resistance trained ($P<0.001$) individuals, suggesting a reduction in skeletal muscle lipid content. Changes in muscle attenuation in endurance trained and resistance trained individuals, however, were not related ($r=0.24$;NS) to improved insulin sensitivity.

DISCUSSION

Insulin resistance is linked with physical inactivity, increased visceral fat and alterations in skeletal muscle characteristics. Moreover, we have shown these obesity-related phenotypes can be present even in normal weight, apparently healthy, young women (11). Thus, interventions to improve or prevent the deterioration of the metabolic profile in this population have significant public health interest. The major findings are that both endurance and resistance training improve glucose disposal in young women, although by different mechanisms. An increase in the quantity of fat-free mass from resistance training contributes to increased glucose disposal probably from a "mass effect" without altering the intrinsic capacity of the muscle to respond to insulin. On the other hand, endurance training enhances glucose disposal independent of changes in fat-free mass, fat mass or VO_2max, suggestive of an intrinsic change in the muscle to metabolize glucose.

Our experimental approach and the methods used lend credibility to our findings. That is, volunteers were randomly assigned to treatment conditions which controls for known and unknown sources of experimental bias and subject self-selection; second, the use of a control group decreases the influence of a "placebo effect"on our results and third, the application of euglycemic/hyperinsuliemic clamps and radiologic imaging techniques provide direct measures of body composition and regional fat.

We originally hypothesized that endurance training would improve insulin sensitivity to a greater degree than resistance training, due to a greater reduction in total fat and visceral fat. The physiological basis underlying our hypothesis is derived from several lines of evidence. First, endurance training may preferentially reduce visceral fat (28). Second, lower levels of visceral fat are associated with higher levels of insulin sensitivity and an improved metabolic profile (15-18, 29-30). This hypothesis, however, was only partially supported by our findings. That is, endurance training improved insulin sensitivity to a greater degree than resistance training, when expressed on an absolute basis or indexed per kilogram of fat-free mass. However, no change in total body fat, intra-abdominal fat or subcutaneous abdominal fat was found in endurance trained women. Although it has been suggested that exercise training leading to a reduction in body fat is a prerequisite to improve glucose disposal (31), our findings, as well as others (32), would refute this assertion. Our results suggest that a vigorous program of endurance training improves glucose disposal, independent of a reduction in total and regional body fat in nonobese young women.

It is probable that the volume of endurance exercise used in this study was inadequate to significantly modify total or regional body fat. in young women who are not restricting their energy intake. Indeed, it is possible that increased energy expenditure in this population is compensated for by a greater energy intake, thus blunting any detectable change in total or regional body fatness (33,34). Another potential reason underlying the absence of changes in body fatness is the potential of a "ceiling effect." That is, it is difficult to reduce total or visceral fat in young women whose baseline levels are already low; unless energy restriction is superimposed upon the exercise program (16,18). This concept is supported by the findings of Wilmore and colleagues (35). They found a small reduction in intra-abdominal fat (-3.1 ± 0.7 cm^2; mean ± SE) in 299 overweight young women after a similar endurance training program. This small decrement in intra-abdominal fat, compared to the absence of changes in our study, probably reflects their greater baseline intra-abdominal values in their overweight cohort (67 ± 45 cm^2), compared to our nonobese women (40 ± 11 cm^2). Unfortunately, no measure of insulin sensitivity was reported in this investigation, thus rendering the effects of a modest reduction in intra-abdominal fat on insulin sensitivity unknown. It is likely that the volume of physical activity performed in the present study may be more beneficial in preventing increases in total and regional fat with advancing age, rather than promoting fat loss (36,37).

Since insulin mediated glucose disposal occurs mainly in muscle, one would hypothesize that an increase in the skeletal muscle mass component of fat-free mass would augment glucose disposal. Our data support this suggestion as the absolute change in glucose disposal (mg/min) was related to the increase in fat-free mass ($r=0.48; P<0.05$) after resistance training. There was no change, however, in glucose disposal when indexed per kilogram of fat-free mass. We interpret this finding to suggest that improved insulin sensitivity probably reflects a "mass effect," without altering the intrinsic capacity of the muscle to respond to insulin. The failure of resistance training to enhance insulin sensitivity per kilogram of fat-free mass could be due to the inability of resistance exercise to increase muscle capillary density (38) or to change muscle fiber types toward an insulin sensitive direction (39). It is unlikely, however, that the improved insulin sensitivity is due to the residual effects of the last exercise bout. Although the acute effects of a single bout of exercise on glucose disposal can persist for several days (40-43), our measurements were conducted six days after the last exercise session, suggesting our observations are more reflective of a chronic adaptation.

We also considered the hypothesis that changes in lipid content within the skeletal muscle may predict changes in insulin sensitivity in women undergoing exercise training. This hypothesis is based on recent data showing that fat deposition within muscle may be an important aspect of body composition that is linked to insulin resistance (15,16,19). We used computed tomography imaging to examine skeletal muscle at the level of the mid-thigh. We noted an increase in the attenuation values in endurance and resistance trained women, which most likely reflects a decrease in skeletal muscle fat content. However, we noted no relation between the improved glucose disposal and increased muscle attenuation values in endurance trained or resistance trained women (r=0.24;NS). Thus, it is likely that other mechanisms are operative. For example, several investigators have suggested that the long-term regulation of the number and function of glucose transporters (44,45); capillary proliferation (46) and the number of IIa (red glycolytic) fibers, which have a higher GLUT-4 content and are more insulin responsive (47) are implicated in the improved insulin sensitivity in response to chronic exercise.

We identified only three reports in the literature (6,48,49) that examined the effects of endurance and resistance training on proxy measures of insulin sensitivity. These studies, however, are not directly comparable to the present investigation because of differences in age, sex, initial metabolic characteristics of the volunteers and experimental design differences. Two of these studies (6,48) were performed in older men with untreated abnormal glucose regulation. Moreover, volunteers self-selected their mode of exercise, which raises questions regarding the biases introduced with subject self-selection. Both of these studies used an oral glucose tolerance test and found that endurance and resistance training reduced plasma glucose and insulin responses to an equivalent oral glucose load, suggestive of improved glucose tolerance and insulin sensitivity. On the other hand, Eriksson and colleagues (49) examined older men and women in a six month non-randomized endurance training study and found no discernible effect on insulin sensitivity, as measured by an intravenous glucose tolerance test. A second study involved a 10-week circuit training program and found improved insulin sensitivity (23%) in eight males, as assessed from a euglycemic/hyperinsulinemic clamp technique. We would suggest that additional randomized studies, such as our own, using similar methodologies and in different populations are needed to confirm our findings.

During the conduct of the protocol, 28 women dropped out of the study, yielding a dropout rate of 36%. This was higher than anticipated, as we had originally planned on a dropout rate of 20%. Interestingly, the majority of these dropouts were women randomized to the endurance training program. The incidence of injury was highest in this arm of the study despite the attention to adequate exercise progression, warm-up/warm down activities, treatment of injuries, etc. These findings potentially highlight the challenges for untrained, younger women to remain compliant in an endurance exercise program given the high injury and noncompliance rate.

In summary, enhanced glucose uptake after physical training in young women occurs with and without a change in fat-free mass and body composition. Two different mechanisms appear to be operative. Improved insulin sensitivity in resistance trained women is probably due to a "mass effect" (ie, increased fat-free mass), whereas endurance training enhances glucose disposal independent of changes in fat-free mass or VO_2max, suggestive of an intrinsic change in the muscle to metabolize glucose. We conclude that both endurance and resistance training are effective interventions to enhance glucose disposal in young, non-obese women.

REFERENCES

1. **Henriksson J.** 1995 Influence of exercise on insulin sensitivity. J Cardiov Risk. 2:303-309.

2. **Buemann B, Tremblay A.** 1996 Effects of exercise training on abdominal and related metabolic complications. Sports Med. 21:191-212.

3. **Perseghin G, Price TB, Petersen KF, Roden M, Cline GW, Gerow K, Rothman DL, Shulman GI.** 1996. Increased glucose transport-phosphorylation and muscle glycogen synthesis after exercise training in insulin resistance subjects. N Eng J Med 335: 1357-1362.

4. **DeFronzo RA, Sherwin RS, Kraemer N. 1987.** Effect of physical training on insulin action in obesity. Diabetes 36: 1379-1385.

5. **Holloszy JO and Narahara HJ.** 1965 Studies of tissue permeability. X. Changes in permeability of 3-methyl-glucose associated with contraction of isolated frog muscle. J Biol Chem. 240:3493-3500.

6. **Smutok MA, Reece C, Kokkinos PF, Farmer CM, Dawson P, Shulman R, DeVane-Bell J, Patterson P, Charabogos C, Goldberg AP, Hurley BF.** 1993 Aerobic versus strength training for risk factor intervention in middle aged-men at high risk for coronary heart disease. Metabolism. 42:177-184.

7. **Craig BW, Everhart J, Brown A..** 1989 The influence of high-resistance training on glucose

tolerance in young and elderly subjects. Mech Ageing Dev. 49:147-157.

8. Miller WJ, Sherman WM, Ivy JL. 1984 Effect of strength training on glucose tolerance and post-glucose insulin response. Med Sci Sports Exerc. 16:539-543.

9. Gater DR, Gater DA, Uribe JM, Bunt JC. 1992 Effects of arginine/lysine supplementation and resistance training on glucose tolerance. J Appl Physiol. 72:1279-1284.

10. Nauutila P, Knuuti MJ, Maki M, Laine H, Ruostalainen U, Teras M, et al. 1995 Gender and insulin sensitivity in the heart and in skeletal muscles. Studies using positron emission tomography. Diabetes. 44: 31-36.

11. Dvorak RV, DeNino WF, Ades PA, Poehlman ET. 1999 Phenotypic characteristics associated with insulin resistance in metabolically obese but normal weight young women. Diabetes 48: 2210-2214.

12. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. 1994 Increasing prevalence of overweight among US adults. The National Health and Nutrition Examination Surveys, 1960 to 1991. JAMA. 272:205-211.

13. The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 22:S5-S19.

14. **Uusitupa MI, Niskanen LK, Siitonen O, Voutilainen E, Pyorala K.** 1990 5-year incidence of atherosclerotic vascular disease in relation to general risk factors, insulin level, and abnormalities in lipoprotein composition in non-insulin-dependent diabetic and nondiabetic subjects. Circulation. 82:27-36.

15. **Goodpaster BH, Thaete FL, Simoneau JA, Kelley DE.** 1997 Subcutaneous abdominal fat and thigh muscle composition predict insulin sensitivity independent of visceral fat. Diabetes. 46:1579-1585.

16. **Goodpaster BH, Kelley DE, Wing RR, Meier A, Thaete FL.** 1999 Effects of weight loss on regional fat distribution and insulin sensitivity in obesity. Diabetes. 48:839-847.

17. **Kirwan JP, Kohrt WM, Wojta DM, Bourey RE, Holloszy JO.** 1993 Endurance exercise training reduces glucose-stimulated insulin levels in 60- to 70- year old men and women. J Gerontol. 48:M84-M90.

18. **Ross R, Fortier L, Hudson R.** 1996 Separate associations between visceral and subcutaneous adipose tissue distribution, insulin and glucose levels in obese women. Diabetes Care. 19:1404-1411.

19. **Pan DA, Lilloja S, Kriketos AD, Milner MR, Baur LA, Bogardus C, Jenkins AB, Storlien LH.** 1997 Skeletal muscle triglycride levels are inversely related to insulin action. Diabetes. 46:983-988.

20. **Tchernof A, Starling RD, Walston JD, Shuldiner AR, Dvorak RV, Silver K, Matthews DE, Poehlman ET.** 1999 Obesity-related phenotypes and the β3-adrenoceptor gene variant in postmenopausal women. Diabetes. 48:1425-1428.

21. Poehlman ET, Gardner AW, Goran MI, Calles-Escandon J. 1994 Effects of endurance training on total fat oxidation in elderly persons. J Appl Physiol. 76:2281-2287.

22. Poehlman ET, Danforth E Jr. 1991 Endurance training increases metabolic rate and norepinephrine appearance in older individuals. Am J Physiol. 261:E233-E239.

25. DeFronzo RA, Tobin JD, Andres R. 1979 Glucose clam technique: a method for quantifying insulin secretion and resistance. Am J Physiol. 237:E214-E233.

26. Garcia-Rubi E, RD Starling, A Tchernof,, DE Matthews, JD Walston, AR Shuldiner, K Silver, ET Poehlman, J Calles-Escandon. 1998 Trp64 Arg variant of the β3-adrenoceptor and insulin resistance in obese postmenopausal women. J Clin Endocrinol Metab 83: 4002-4005.

27. DeFronzo RA: Glucose intolerance and aging: evidence for tissue insensitivity to insulin. 1979 *Diabetes* 28:1095-1101.

28. Schwartz RS, Shuman WP, Larson V, Cain DC, Fellingham GW, Beard JC, Kahn SE, Stratton JR, Cerqueira MD, Abrass IB. 1991 The effect of intensive endurance exercise training on body fat distribution in young and older men. Metabolism. 40:545-551.

29. Després JP, Pouliot MC, Moorjani S, Nadeau A, Tremblay A, Lupien PH, Thériault G, Bouchard C. 1991 Loss of abdominal fat and metabolic response to exercise training in obese women. Am J Physiol

261: E159-!67.

30. Brochu M, Starling RD, Tchernof A, Matthews DE, Poehlman ET. (in press). Visceral adipose tissue is an independent correlate of glucose disposal in older obese postmenopausal women. J Clin Endocrinol Metab.

31. Segal KR, Edano E, Abalos A, Albu J, Blando L, Tomas MB, Xavier Pi-Sunyer F. 1991 Effects of exercise training on insulin sensitivity and glucose metabolism in lean, obese and diabetic men. J Appl Physiol. 71:2402-2411.

32. Hughes VA, Fiatarone MA, Fielding RA, Kahn BB, Ferrara CM, Shepherd S, Fisher EC, Wolfe RR, Elahi D, Evans WJ. 1993 Exercise increases glut-4 levels and insulin action in subjects with impaired glucose. Am J Physiol. E855-E862.

33. Poehlman ET and ES Horton. Determinants of Body Weight Regulation. 1992 In: *Eating, Body Weight, and Performance in Athletes: Disorders of Modern Society.* Eds: KD Brownell, J Rodin, and JH Wilmore.

34. Poehlman ET, Gardner AW, Goran MI. 1990 The impact of physical activity and cold exposure on food intake and energy expenditure in man. J Wilderness Med 1: 265-278.

35. Wilmore JH, Despres JP, Stanforth PR, Mandel S, Rice T, J Gagnon, Leon AS, Rao DC, Skinner JS, Bouchard C. 1999 Alterations in body weight and composition consequent to 20 wk of endurance training: the HERITAGE Family Study. Am J Clin Nutr. 70:346-352.

36. **Poehlman ET, Toth MJ, Bunyard LB, Gardner AW, Donaldson KE, Colman E, Fonong T, Ades PA.** 1995 Physiological predictors of increasing total and central adiposity in aging men and women. Arch Int Med. 155:2443-2448.

37. **Wilmore JH.** 1996 Increasing physical activity: alterations in body mass and composition. Am J Clin Nutr. 63:(suppl) 465S-460S.

38. **Hepple RT, Mackinnon SLM, Goodman JM, Thomas SG, Plyley MJ.** 1997 Resistance and aerobic training in older men: effects on VO_2 peak and the capillary supply to skeletal muscle. J Appl Physiol 82: 1305-1310.

39. **Tesch PA, Thorsson A, Kaiser P.** 1984 Muscle capillary supply and fiber type characteristics in weight and power lifters. J Appl Physiol 56: 35-38.

40. **Burstein R, Polychronakos C, Toeus CJ, BacDougall JC, Guyda HJ, Posner BI.** 1985 Acute reversal of the enhanced insulin action in trained athletes. Diabetes. 34:756-760.

41. **Heath GW, Gavin JR, Hinderliter JM, Hagbert J, Bloomfield SA, Holloszy JO.** 1983 Effects of exercise and lack of exercise on glucose tolerance and insulin sensitivity. J Appl Physiol. 55:512-517.

42. LeBlanc J, Nadeau A, Richard D, Tremblay A. 1981 Studies on the sparing effect of exercise on insulin requirements in human subjects. Metabolism. 30:1119-1124.

43. Mikines KJ, Sonne B, Farrell PA, Tronier B, Galbo H. 1988 Effect of physical exercise on sensitivity and responsiveness to insulin in humans. Am J Physiol. 254:E248-E259.

44. Houmard JA, Egan PC, Neufer PD, Friedman JE, Wheeler WS, Israel RG, et al. 1991 Elevated skeletal muscle glucose transporter levels in exercise-trained middle-aged men. Am J Physiol. 261:E437-E443.

45. Goodyear LJ, Hirshman MF, Valyou PM, Horton ES. 1992 Glucose transporter number, function and subcellular distribution in rat skeletal muscle after exercise training. Diabetes 41 1091-1099.

46. Andersen P, Henriksson J. 1977 Capillary supply of the quadriceps femoris muscle of man: adaptive response to exercise. J Physiol 270: 677-690.

47. Ebeling R Bourey, Koranyi L, Tuominen JA, Groop LC, Henriksson J, et al. 1993 Mechanism of enhanced insulin sensitivity in athletes. Increased blood flow, muscle glucose transport protein (glut-4) concentrations, and glycogen synthase activity. J Clin Invest. 92:1623-1631.

48. Smutok MA, Reece C, Kokkinos PF, Farmer CM, Dawson PK, DeVane J, Patterson J, Goldberg AP, Hurley BF. 1994 Effects of exercise training modality on glucose tolerance in men with abnormal glucose regulation. Int J Sports Med. 15:283-289.

49. Eriksson J, Turminen J, Valle T, Sundberg S, Sovijarvi A, Lindholm H, Tuomilehto J, Kovisto V. 1998 Aerobic endurance exercise or circuit-type resistance training for individuals with impaired glucose tolerance. Horm Metab Res. 30:37-41.

FIGURE LEGENDS

Figure 1: Changes in insulin sensitivity before and after endurance training, resistance training and control conditions. Panel A are values expressed on an absolute basis and Panel B are values indexed per kilogram of fat-free mass. Values are means ± SE. * $P<0.05$

ACKNOWLEDGMENTS

We would like to thank all participants for their time and effort in this study. We would also like to thank Ms Denise DeFalco-McGeein, RNC, NP for her clinical management of our volunteers. Appreciation is also extended to the administration and staff at the Racquets Edge Health Club in Essex, Vermont. This work was supported by a grant from the Department of Defense to Dr Poehlman (DE 950226), a postdoctoral fellowship from the American Heart Association, Maine/New Hampshire/Vermont affiliate to Dr R Dvorak and a grant from the Medical Research Council of Canada to Dr M Brochu and GRCR grant no RR-109. We would like to thank Travis Beckett and Kristan Kinamin for training our volunteers. Appreciation is expressed to Drs Michael J Toth and André Tchernof for their thoughtful comments on the paper.

Table 1: Changes in characteristics of younger women before and after training.

Physical Characteristic	Endurance training (n=14)		Resistance training (n=17)		Control (n=20)	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Age (yr)	29 ± 5	-	28 ± 3	-	28 ± 4	-
VO_{2max} (L/min)	2.1 ± 0.5	2.7 ± 0.5**	2.1 ± 0.4	2.2 ± 0.3	2.2 ± 0.5	2.3 ± 0.4
Height (cm)	163 ± 5	-	164 ± 7	-	165 ± 7	-
Body weight (kg)	59 ± 5	59 ± 5	58 ± 6	60 ± 6*	60 ± 7	61 ± 8
BMI (kg/m^2)	22 ± 2	22 ± 2	22 ± 2	23 ± 2*	22 ± 2	22 ± 2
DEXA measures						
Fat mass (kg)	16 ± 5	15 ± 4	16 ± 4	17 ± 4	17 ± 6	17 ± 6
Fat free mass (kg)	40 ± 4	40 ± 4*	39 ± 4	41 ± 3**	39 ± 4	40 ± 3

Values are means ± SD. * $P < 0.05$, ** $P < 0.001$; BMI; body mass index; pre/post= six months of endurance or resistance training

Table 2: Physical characteristics of individuals who did not complete that training programs

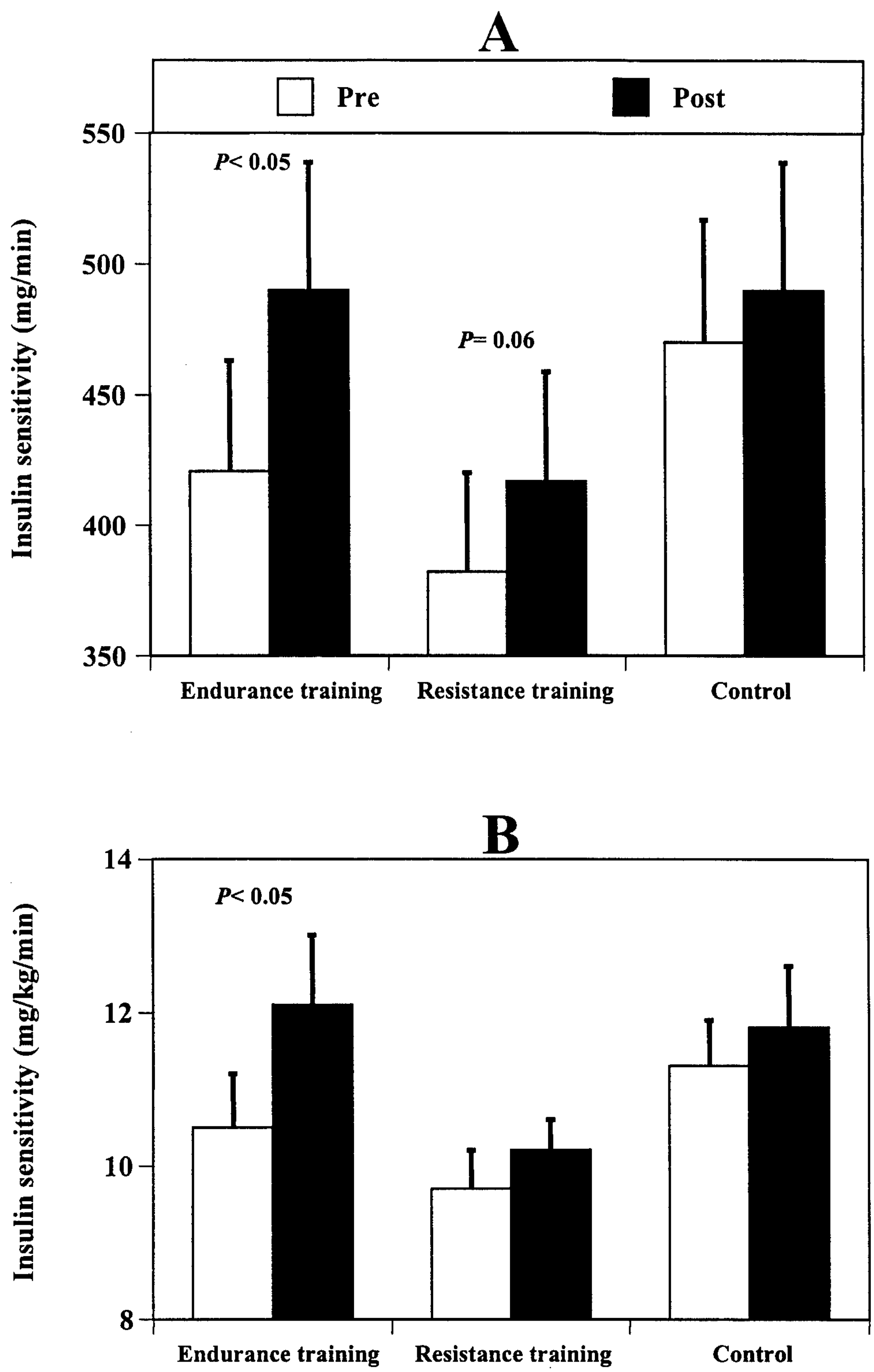
Characteristic	Dropouts (n= 28)
Age (yr)	29 ± 4
VO_{2max} (L/min)	1.9 ± 0.2
IS (mg/kgFFM/min)	10.2 ± 3.1
Height (cm)	166 ± 7
Body weight (kg)	61 ± 9
DEXA measures	
Fat mass (kg)	18 ± 6
Fat free mass (kg)	40 ± 5
CT scan measures	
SAT (L4-L5, cm^2)	184 ± 84
VAT (L4-L5, cm^2)	41 ± 17
Thigh fat area (cm^2)	109 ± 37
Thigh muscle area (cm^2)	108 ± 15
Muscle attenuation (HU)	48 ± 2

Values are means ± SD. SAT= subcutaneous adipose tissue, VAT= visceral adipose tissue; M/FFM = glucose disposal expressed per kilogram of fat-free mass. These variables are not different than the subjects who completed the study.

Table 3: Changes in abdominal adiposity, thigh adipose and lean tissue content in younger women before and after training.

Physical Characteristic	Endurance training (n=14)		Resistance training (n=17)		Control (n=20)	
	Pre	Post	Pre	Post	Pre	Post
CT scan measures						
SAT area (L4-L5, cm^2) 1	194 ± 86	193 ± 80	186 ± 74	186 ± 85	147 ± 66	210 ± 95
VAT area (L4-L5, cm^2)	40 ± 11	41 ± 13	36 ± 17	36 ± 13	36 ± 13	41 ± 15
Thigh fat area (cm^2)	98 ± 34	90 ± 24	108 ± 32	102 ± 38	98 ± 29	101 ± 31
Thigh muscle area (cm^2)	108 ± 11	114 ± 14	109 ± 19	115 ± 16	119 ± 16	113 ± 17
Muscle attenuation (HU)	49 ± 3	51 ± 1*	50 ± 2	52 ± 1*	48 ± 2	48 ± 2

Values are means ± SD. SAT= subcutaneous adipose tissue, VAT= visceral adipose tissue; HU= Hounsfield Units; * $P < 0.05$


A
Pre
Post
Insulin sensitivity (mg/min)
550
500
450
400
350
P< 0.05
P= 0.06
Endurance training
Resistance training
Control
B
Insulin sensitivity (mg/kg/min)
14
12
10
8
P< 0.05
Endurance training
Resistance training
Control

Appendix III

LAST NAME	FIRST NAME	Nomat	Age	Ethnic	group	orcon	Start	Situtation	Status	Pre Date	Post Date
		nomat	Age	Ethnic	group	orcon	Start	Situtation	Status	Pre Date	Post Date
Abell	Susan	667001	29	w	1	0	7/23/97	dropout	3	7/10/97	
Ahearn	Erin	667002	25	w	2	1	2/23/98	done-paid	2	2/13/98	9/18/98
Alberts	Heather	667003	24	w	2	1	5/28/97	dropout	3	5/1/97	
Antoniuc	Shauna	667004	24	w	1	1	3/5/99	in-training	1	3/2/99	
Betten	Paige	667005	30	w	2	0	3/11/99	in-training	1	2/23/99	
Bevins	Lynda	667006	32	w	1	0	2/1/98	in-training	1	1/26/98	
Blaiklock	Jennifer	667007	33	w	3	0	5/19/97	done-paid	2	5/9/97	12/11/97
Blake	Angela	667008	24	w	2	1	6/18/99	in-training	1	5/19/99	
Boe	Mary Beth	667009	27	w	2	1	5/9/97	done-paid	2	4/28/97	12/18/97
Bognar	Janina	667010	22	w	3	1	6/9/97	done-paid	2	5/29/97	12/19/97
Boucher	Ann	667011	31	w	3	0	3/20/97	done-paid	2	3/10/97	9/19/97
Boyd	Kristen	667012	26	w	2	1	6/18/97	done-paid	2	5/21/97	1/14/98
Brennan	Kasara	667013	21	w	3	1	2/17/97	dropout	3	1/29/97	
Bragg	Denise	667014	33	w	1	0	2/23/98	done-paid	2	2/6/98	10/14/98
Brice	Whitney	667015	30	w	1	1	2/26/97	done-paid	2	2/7/97	10/17/97
Brigham	Heidi	667016	28	w	2	1	5/28/97	dropout	3	5/16/97	
Brochu	Kara	667017	34	w	2	1	6/30/97	done-paid	2	6/20/97	12/23/97
Brown	Anna	667018	34	w	2	0	3/10/97	done-paid	2	2/28/97	9/16/97
Brown	Kimball	667019	33	w	1	1	4/8/98	done-paid	2	3/26/98	10/15/98
Bruce	Jennifer	667020	23	w	2	0	3/21/97	dropout	3	3/11/97	
Brulatour	Maria	667021	27	w	2	1	12/19/97	done-paid	2	12/4/97	6/25/98
Caldwell	Paige	667022	31	w	2	0	3/10/97	dropout	3	2/28/97	
Camp	Karen	667023	33	w	1	1	July '98	done-paid	2	6/19/98	1/8/99
Carlson	Kristin	667024	29	w	3	1	5/12/97	done-paid	2	5/2/97	4/9/98
Casale	Leanne	667025	25	w	1	0	3/3/97	done-paid	3	2/20/97	
Cass	Wendy	667026	26	w	3	0	2/27/97	done-paid	2	2/17/97	8/15/97
Chase	Lynette	667027	33	w	3	0	8/11/97	done-paid	2	8/1/97	3/5/98
Chicoine	Kim	667028	31	w	1	1	5/18/97	dropout	3	5/7/97	
Chien	Lyressa	667029	30	h	2	1	5/26/99	in-training	1	5/25/99	
Chiu	Cynthia	667030	20	a	3	0	3/31/97	done-paid	2	3/21/97	12/30/97
Colelli	Donna		34	w		0	7/14/99	in-training	2	7/14/99	
Companion	Amy	667031	24	w	2	1	4/20/98	done-paid	2	4/10/98	11/30/98
Cruise	Linda	667032	33	w	1	0		drop-out	3	4/23/98	
Cutter	Susan	667033	23	w	2	1	3/3/97	done-paid	2	2/18/97	8/12/97
Descoteaux	Maureen	667034	33	w	1	0	5/19/97	dropout	3	5/9/97	

Erdmann	Lisa	667035	29	w	2	0	2/16/98	done-paid	2	2/3/98	8/10/97
Gagne	Havalah	667036	24	w	3	0	1/10/97	done-paid	2	8/26/97	3/6/98
Gallo	Michelle	667037	22	w	1	0	10/6/97	done-paid	2	9/23/97	4/24/98
Gear	Amy	667038	31	w	2	0	10/13/97	dropout	3	10/2/97	
Geelmuyden	Jenifer	667039	27	a	2	1		dropout	3	9/3/97	
Glaspie	Elizabeth	667040	33	w	1	0		in-training	1	12/10/98	7/20/99
Grennon	Gertrude	667041	24	w	1	1	4/9/97	done-paid	2	3/28/97	10/24/97
Hanson	Sara	667042	25	w	1	1	2/17/97	dropout	3	1/23/97	
Johnson	Mitzi	667043	26	w	1	0	6/13/97	dropout	3	5/22/97	
Joy	Dierdra	667044	33	w	1	0	10/1/97	done-paid	2	9/18/97	5/20/97
King	Julie	667045	26	w	2	1	3/1/99	in-training	2	2/24/99	
Krcmar	Chantal	667046	24	w	1	0	5/1/98	done-paid	2	4/22/98	11/18/98
Ladd	Donna	667047	28	w	2	0	6/23/97	dropout	3	6/13/97	
Lescaze	Miranda	667048	26	w	2	1	1/4/99	done-paid	2	12/11/98	7/12/99
Llauger	Giannina	667049	23	h	1	0	2/24/97	done-paid	2	2/11/97	10/7/97
Lush	Tamara	667050	28	w	1	0	6/7/99	in-training	1	6/4/99	
MacLachlan	Catherine	667051	26	w	2	1	6/16/97	done-paid	2	6/4/97	1/8/98
Marland	Dawn	667052	34	w	1	0	6/1/97	dropout	3	5/15/97	
Mason	Carol Lee	667053	35	w	3	0	6/16/97	done-paid	2	6/5/97	1/22/98
Matthews	Stacey	667054	27	w	2	1	9/25/98	dropout	3	8/28/97	
McKenny	Heather	667055	29	w	3	1	4/25/97	done-paid	2	4/15/97	11/25/97
Medved	cara		29	w		1	6/9/99	in-training	1	6/23/99	
Mercier	Jennifer	667056	28	w	3	1	11/20/98	done-paid	2	11/20/98	6/23/99
Mills	Jennifer	667057	26	w	1	0	3/3/97	done-paid	2	2/19/97	9/12/97
Moirano	Kimberley	667058	35	w	1	1	5/30/97	done-paid	2	5/20/97	12/6/97
Moreno	Joan	667059	32	w	1	0	6/16/97	dropout	3	6/5/97	
Morgan	Lynne	667060	26	w	2	1	4/10/98	done-paid	2	4/1/98	10/21/98
Nieves	Yanaris	667061	23	h	2	0	2/24/97	dropout	3	2/6/97	
Olmstead	Jennifer	667062	28	w	3	0	3/17/97	done-paid	2	3/6/97	11/11/97
Padnos	Rebecca	667063	33	w	1	0	6/20/97	dropout	3	6/11/97	
Phillips	Maribel	667064	32	h	1	0	6/7/99	in-training	1	6/3/99	
Previs	Lisa	667065	25	w	1	0	5/7/97	done-paid	2	4/24/97	11/21/97
Quick	Denise	667066	34	w	2	0	3/12/97	dropout	3	2/26/97	
Raab	Patricia	667067	27	w	2	1	4/14/99	in training	1	4/14/99	
Randall	Erin	667068	22	w	3	1	8/1/97	done-paid	2	7/23/97	3/9/98
Record	Norma	667069	28	w	2	1	8/3/98	done-paid	2	6/23/98	2/6/99
Roddy	Margaret	667070	33	w	3	1	3/28/97	done-paid	2	3/18/97	1/6/98

Ruesink	Adreana	667071	26	w	1	0	3/23/97	done-paid	2	3/12/97	10/1/97
Sarabia	Paige	667072	24	w	2	1	7/14/97	dropout	3	7/1/97	
Scolin	Lynda	667073	29	w	3	1	6/23/97	done-paid	2	6/13/97	1/23/98
Scribner	Shirley	667074	28	w	1	0	1/21/98	dropout	3	1/9/98	
Shannon	Joan	667075	33	w	2	0	8/24/98	in-training	2	8/13/98	2/9/99
Siegel	Amy	667076	29	w	1	1	6/9/97	dropout	3	5/30/97	
Silverman	Julie	667077	32	w	3	0	12/11/98	done-paid	2	12/2/98	6/24/99
Smith	Christina	667078	33	w	3	0	6/16/97	done-paid	2	6/6/97	1/13/98
Sullivan		667079									
Teague	Jennifer	667080	25	w	2	1	3/29/97	done-paid	2	3/19/97	10/10/97
descoteaux	Mary	667081	27		1	0	3/15/99	in-training	1	3/9/99	
Vieira	Aimee	667082	27	w	3	1	11/1/98	in-training	1	10/19/98	7/15/99
Walker	Kerry	667083	27	w	2	0	Dec. 99	done-paid	2	11/16/98	6/21/99
Watson	Rebecca	667084	32	w	2	1		dropout	3	2/4/97	
Wires	Kara	667085	28	w	2	0	Dec. 99	done-paid	2	11/25/98	
Wyss	Vanessa	667086	23	w	3	0	6/30/97	done-paid	2	6/19/97	1/29/98
Yezerski	Ann	667087	26	w	3	1	2/21/97	done-paid	2	2/10/97	9/4/97
Zarrillo	Nicole	667088	27	w	2	1	5/10/98	dropout	3	4/30/98	

height1	weight1	BMI1	height2	weight2	BMI2	sbp_1	sbp_2	dbp_1	dbp_2	BMD total (g/cm2)	BMD total 2
height1	weight1	BMI1	height2	weight2	BMI2	sbp_1	sbp_2	dbp_1	dbp_2	BMD total (g/cm3)	BMD total 2
166.0	67.7	24.6				122.0		76.0		1.205	
174.8	68.2	22.3	174.0	73.0	24.1	130.0		80.0		1.193	1.209
169.9	55.5	19.2				132.0		70.0		1.160	
169.6	61.4	21.3				129.0		67.0		1.061	
159.4	47.1	18.5				114.0		68.0			
162.6	45.1	17.1				108.0		77.0		1.053	
162.0	52.5	20.0	161.6	52.9	20.3	105.0		73.0		1.160	1.179
173.0	60.0	20.0								1.097	
166.2	55.9	20.2	166.2	55.8	20.2	129.0		75.0		1.216	1.263
163.0	55.0	20.7	163.0	55.3	20.8	115.0		72.0		1.135	1.110
152.0	50.0	21.6	152.0	49.5	21.4	123.0		87.0		1.074	1.229
163.6	59.3	22.2	164.0	60.0	22.3	112.0		75.0		1.140	1.166
171.4	57.5	19.6				137.0		85.0		1.182	
156.8	61.3	24.9	156.8	62.2	25.3	115.0		62.0		1.257	1.254
166.0	65.0	23.6	166.0	64.9	23.6	99.0		52.0		1.172	1.172
170.2	59.9	20.7				115.0		56.0		1.108	
151.0	58.2	25.5	151.0	60.7	26.6	114.0		56.0		1.284	1.299
173.2	58.1	19.4	172.8	60.9	20.4	100.0		60.0		1.180	1.231
166.6	66.3	23.9	166.8	66.4	23.9	108.0		61.0		1.239	1.236
163.6	52.3	19.5				99.0		52.0		1.125	
171.4	47.2	16.1	171.4	52.4	17.8	128.0		74.0		1.154	1.172
177.8	83.0	26.3				128.0		67.0		1.287	
162.6	53.5	20.2	161.8	54.2	20.7	109.0		74.0		1.100	1.103
168.0	54.0	19.1	168.0	56.8	20.1	105.0		74.0		1.047	1.086
165.4	63.9	23.4				138.0		73.0		1.170	
165.0	54.1	19.9	164.4	51.2	18.9	133.0		86.0		1.226	1.238
154.6	50.4	21.1	158.2	49.3	19.7	108.0		77.0		1.155	1.134
171.6	59.3	20.1				122.0		60.0		1.185	
160.7	61.8	23.9								1.201	
156.3	58.3	23.9	156.4	59.2	24.2	116.0		65.0		1.146	1.172
164.0	68.0	25.3								1.100	
163.2	66.7	25.0	163.2	67.1	25.2	103.0		64.0		1.158	1.155
162.4	62.9	23.8				130.0		75.0		1.150	
156.6	53.0	21.6	156.0	56.7	23.3	129.0		83.0		1.130	1.141
176.6	81.5	26.1				122.0		60.0		1.197	

166.8	59.5	21.4	166.8	62.4	22.4	129.0		79.0		1.157	1.165
162.4	56.7	21.5	161.6	53.4	20.4	114.0		77.0		1.156	1.139
159.0	55.2	21.8	159.0	55.4	21.9	100.0		62.0		1.112	1.124
149.2	40.2	18.1				100.0		74.0		1.159	
151.4	46.2	20.2				100.0		65.0		1.114	
165.2	53.8	19.7	165.2	53.60	19.6	106.0		55.0		1.078	1.083
161.2	56.6	21.8	161.2	57.1	22.0	98.0		60.0		1.159	1.195
164.0	67.2	25.0				116.0		86.0		1.154	
167.0	59.7	21.4				113.0		59.0		1.170	
163.0	55.4	20.9	163.0	57.4	21.6	107.0		53.0		1.208	1.230
167.7	55.9	19.9				137.0		72.0		1.145	
172.0	57.6	19.5	172.0	59.0	19.9	122.0		74.0		1.146	1.137
162.4	60.4	22.9				129.0		68.0		1.176	
165.3	55.0	20.1	164.6	55.5	20.5	115.0		64.0		1.210	1.219
163.4	54.0	20.2	163.4	53.4	20.0	130.0		68.0		1.245	1.222
158.4	55.3	22.0								1.159	
158.6	58.8	23.4	158.6	59.4	23.6	113.0		67.0		1.224	1.226
164.4	60.0	22.2				114.0		51.0		1.002	
174.5	63.6	20.9	175.0	66.0	21.6	115.0		65.0		1.257	1.267
174.4	73.8	24.3				171.0		75.0		1.219	
168.0	59.8	21.2	168.0	59.3	21.0	126.0		71.0		1.319	1.379
166.4	70.5	25.5								1.220	
165.4	60.4	22.1	166.0	61.5	22.3	131.0		69.0		1.170	1.156
157.0	51.7	21.0	157.2	54.2	21.9	110.0		56.0		1.116	1.119
163.8	66.3	24.7	163.8	65.4	24.4	129.0		75.0		1.156	1.177
162.8	58.6	22.1				102.0		74.0		1.135	
154.8	50.3	21.0	154.8	52.8	22.0	116.0		70.0		1.042	1.021
167.2	56.1	20.1				116.0		69.0		1.174	
175.0	78.0	25.5	175.0	74.4	24.3	120.0		78.0		1.207	1.218
159.4	57.2	22.5				117.0		70.0		1.168	
152.6	50.9	21.9								1.274	
155.6	60.8	25.1	155.0	60.5	25.2	121.0		82.0		1.151	1.177
164.8	57.9	21.3				108.0		45.0		1.105	
172.2	55.9	18.9								1.389	
172.4	70.1	23.6	172.4	73.0	24.6	122.0		78.0		1.179	1.188
161.0	54.4	21.0	161.0	54.0	20.8	109.0		58.0		1.193	1.190
172.6	69.4	23.3	172.0	77.2	26.1	105.0		55.0		1.260	1.286

172.2	66.4	22.4	172.8	64.4	21.6	112.0		61.0		1.217	1.212
168.4	57.4	20.2				135.0		76.0		0.995	
159.4	61.5	24.2	159.4	64.0	25.2	109.0		57.0		1.052	1.070
170.4	63.0	21.7				107.0		68.0		1.176	
180.0	70.2	21.7	180.0	70.4	21.7	108.0		70.0		1.192	1.218
155.0	53.2	22.1				153.0		89.0		1.133	
167.8	69.9	24.8	168.0	71.0	25.2	110.0		69.0		1.208	1.164
166.8	62.2	22.4	166.8	61.3	22.0	147.0		85.0		1.283	1.286
163.0	53.2	20.0	163.0	53.5	20.1	103.0		65.0		1.121	1.114
163.0	62.0	23.3								1.260	
175.4	64.4	20.9	175.4	66.0	21.5	128.0		66.0		1.192	1.205
164.2	64.8	24.0	165.0	66.8	24.5	137.0		84.0		1.163	1.180
164.6	54.7	20.2				97.0		67.0		1.167	
161.8	60.3	23.0	162.3	60.20	22.9	116.0		65.0		1.235	1.240
154.4	56.0	23.5	154.4	56.5	23.7	109.0		64.0		1.172	1.151
167.6	62.1	22.1	167.6	66.3	23.6	117.0		71.0		1.276	1.000
174.2	67.0	22.1				123.0		76.0		1.111	

BMC tot (g)	BMC tot 2	BMC trunk	BMC trunk2	BMC arms	BMC arms2	BMC legs	BMC legs2	BMD spine	BMD spine2	BMD pelvis	BMD pelvis2	total ca++
BMC tot (g)	BMC tot 2	BMC trunk	BMC trunk2	BMC arms	BMC arms2	BMC legs	BMC legs2	BMD spine	BMD spine2	BMD pelvis	BMD pelvis2	total ca++
2805		888		320		928		1.347		1.071		1066
2777	2892	989	1044	305	332	1014	1047	1.340	1.305	1.210	1.242	1055
2480		811		321		838		1.145		1.228		943
2340		760		294		782		1.302		0.967		889
1999		602		248		713		0.930		0.952		760
2497	2536	779	831	335	299	809	815	1.164	1.059	1.070	1.091	949
2548		948		269		864		1.200		1.045		968
2735	2739	952	975	350	326	929	932	1.313	1.305	1.343	1.354	1039
2441	2406	783	815	300	274	857	832	1.111	1.061	1.026	1.036	928
2233	2198	677	744	265	258	752	738	1.196	1.221	1.075	1.112	826
2508	2551	774	853	345	302	824	820	1.143	1.260	1.115	1.132	953
2744		900		305		1069		1.145		1.221		1043
2433	2495	804	849	281	274	778	789	1.257	1.337	1.177	1.234	925
2744	2789	915	975	332	325	992	993	1.175	1.124	1.098	1.113	1043
2530		879		316		862		1.189		1.138		961
2568	2614	926	946	297	311	875	890	1.212	1.333	1.272	1.290	976
2855	2969	942	938	359	375	950	1027	1.274	1.467	1.152	1.142	1085
2958	2951	1030	993	336	336	1032	1055	1.324	1.388	1.189	1.199	1124
2349		772		276		761		1.142		1.047		892
2324	2398	754	765	278	312	749	763	1.150	1.189	1.064	1.094	883
3373		1169		389		761		1.470		1.242		1282
2350	2360	2350	771	305	310	788	827	1.157	1.228	1.018	1.019	893
2131	2242	627	732	267	266	751	755	0.941	1.091	0.964	0.986	810
2620		851		331		761		1.216		1.157		996
2647	2667	860	853	352	339	761	908	1.219	1.138	1.119	1.134	1006
2137	2177	706	799	264	240	729	711	1.116	1.254	1.121	1.098	812
2726		946		344		931		1.402		1.163		1036
2344		785		252		851		1.247		1.129		891
2456	2575	859	935	288	298	761	828	1.186	1.184	1.139	1.166	933
2310		786		259		719		1.216		0.985		878
2504	2581	898	892	331	366	870	876	1.269	1.265	1.126	1.075	952
2564		968		307		851		1.217		1.117		974
2116	2191	726	786	265	276	761	702	1.062	1.260	1.152	1.169	804
2967		1062		381		1024		1.395		1.252		1128

2341	2385	743	735	312	319	798	833	1.104	1.111	1.109	1.114	890
2543	2536	842	902	324	298	885	869	1.160	1.273	1.159	1.158	966
2281	2312	771	762	269	279	700	713	1.106	1.173	1.087	1.044	867
1922		563		227		739		1.034		1.086		730
1932		583		217		638		0.971		0.980		734
2187	2	706	723	267	261	721	754	1.163	1.224	0.998	0.990	831
2503	2504	861	875	333	289	761	795	1.255	1.149	1.205	1.245	951
2772		951		331		761		1.246		1.075		1053
2376		713		270		938		1.048		1.091		903
2805	2889	965	1054	379	371	905	922	1.235	1.348	1.252	1.303	1066
2444		784		290		860		1.241		1.088		929
2680	2738	907	956	300	296	953	963	1.162	1.185	1.087	1.115	1019
2516		857		359		787		1.197		1.129		956
2400	2557	789	869	281	278	825	844	1.219	1.242	1.162	1.117	912
2528	2534	792	840	304	291	761	805	1.127	1.184	1.130	1.203	961
2415		862		282		776		1.231		1.188		918
2558	2607	885	952	306	302	879	866	1.345	1.242	1.267	1.295	972
2098		648		265		716		0.859		1.010		797
3066	3091	1047	1092	384	381	1052	1037	1.407	1.204	1.297	1.271	1165
3161		1044		369		1178		1.156		1.202		1201
3076	3157	1163	1137	386	438	761	1013	1.522	1.492	1.310	1.313	1169
2884		1037		289		1029		1.385		1.157		1096
2502	2527	848	864	289	274	858	874	1.190	1.129	1.091	1.123	951
2289	2337	781	790	334	331	761	736	1.189	1.156	1.090	1.122	870
2638	2717	911	975	324	310	841	858	1.304	1.156	1.118	1.140	1002
2424		749		310		853		1.151		1.079		921
1997	1984	785	743	200	213	593	605	1.159	1.148	1.084	1.074	759
2593		877		324		761		1.262		1.122		985
2861	2800	985	922	351	363	761	1033	1.117	1.180	1.171	1.200	1087
2343		774		272		802		1.192		1.083		890
2383		826		251		743		1.437		1.340		905
2428	2493	790	867	779	292	314	810	1.196	1.246	1.066	1.071	922
2601		820		351		761		1.227		0.999		988
3217		1149		396		1087		1.390		1.385		1222
2914	3015	1035	1133	364	353	1021	1042	1.235	1.438	1.267	1.260	1107
2512	2500	921	895	293	291	775	773	1.298	1.223	1.202	1.191	955
3033	3155	1093	1134	350	341	761	1070	1.381	1.572	1.251	1.249	1153

3019	2997	1098	1025	354	382	761	1003	1.299	1.243	1.215	1.202	1147
2106		681		280		718		0.933		0.983		800
2027	2096	719	754	250	255	645	677	1.082	1.174	1.050	1.043	770
2699		921		316		956		1.271		1.178		1025
3103	3001	1168	1072	372	371	1020	1011	1.402	1.271	1.140	1.174	1179
2214		752		273		698		1.139		1.062		841
3054	3092	1119	1118	374	375	1015	1049	1.330	1.353	1.163	1.175	1160
2954	2922	1030	1004	367	356	1045	1044	1.227	1.300	1.266	1.255	1123
2269	2286	785	798	265	284	761	782	1.213	1.067	1.117	1.146	862
2714		1040		307		835		1.366		1.274		1031
2982	3034	1082	1135	372	357	1018	1015	1.343	1.398	1.236	1.219	1133
2667	2788	917	986	317	331	906	934	1.204	1.280	1.148	1.134	1014
2646		860		334		761		1.192		1.208		1006
2780	2799	971	999	330	305	880	879	1.265	1.471	1.166	1.176	1056
2368	2355	817	834	320	328	728	706	1.233	1.319	1.177	1.174	900
2912	2989	1053	1097	406	417	761	978	1.321	1.528	1.340	1.381	1106
2822		1026		354		906		1.335		1.065		1072

total ca++2	Tis_Fa1	Tis_Fa2	Regn % fat	Regn % fat2	F_mass1	F_mass2	FF_m1	FF_m2	LTM trunk	LTM trunk	LTM arms	LTM arms2
total ca++2	Tiss_Fat1	Tiss_Fat2	Regn % fat	Regn % fat2	F_mass1	F_mass2	FF_m1	FF_m2	LTM trunk	LTM trunk	LTM arms	LTM arms2
	37.4		35.9		23.99		40.09		18.46		4.40	
1099	36.2	40.90	34.8	39.2	23.66	28.81	41.65	41.71	20.26	19.48	4.26	4.51
	29.5		28.2		15.68		37.44		16.65		4.47	
	31.7		30.4		18.27		39.42		19.05		3.80	
	18.0				8.25		37.48		18.68		3.69	
	16.8		16.1		7.42		36.80		17.61		3.38	
964	24.6	25.5	23.4	24.3	12.24	12.70	37.53	37.03	17.45	18.02	4.33	3.70
	27.4		26.9		15.73		41.68		20.84		3.88	
1041	28.7	23.3	27.3	22.2	15.39	12.40	38.19	40.75	18.04	4.58	4.46	4.58
914	22.4	22.8	21.4	21.8	11.68	11.96	40.44	40.55	18.74	20.31	4.40	3.97
835	27.6	27.0	26.4	25.8	13.13	12.74	34.48	34.48	15.98	17.57	3.76	3.48
969	32.3	28.0	30.9	26.8	18.31	16.07	38.43	41.33	18.02	20.29	4.74	4.66
	15.1		14.4		8.24		46.37		20.86		4.91	
948	33.8	34.2	32.4	32.8	19.75	20.65	38.73	39.77	19.56	20.75	3.81	3.62
1060	25.6	25.8	24.5	24.7	15.88	16.19	46.09	46.45	21.47	23.23	4.87	4.70
	33.0		31.6		18.92		38.44		17.98		4.43	
993	30.1	32.4	28.8	31.0	16.59	18.84	38.46	39.32	19.18	18.86	4.17	4.53
1128	22.7	26.5	21.6	25.2	12.63	15.47	42.98	42.84	19.69	18.93	4.92	5.24
1122	31.0	32.9	29.6	31.4	19.30	20.40	42.93	41.56	20.87	19.63	4.24	4.08
	19.6		18.7		9.74		39.88		20.08		4.14	
911	20.4	23.3	20.4	22.2	9.43	11.58	34.52	38.10	17.47	18.84	3.27	3.97
	38.5		36.9		29.80		47.55		23.24		5.34	
897	22.7	20.60	21.7	19.7	11.62	10.32	39.59	39.75	19.74	18.62	4.56	4.37
852	28.8	29.7	27.6	28.5	14.86	16.09	36.80	38.08	17.17	19.25	4.08	3.85
	30.6		29.3		17.81		40.35		19.36		4.63	
1013	22.9	23.0	21.7	21.8	11.68	11.10	39.40	37.19	19.22	18.07	4.21	3.79
827	23.6	23.8	22.6	22.8	11.17	11.21	36.17	35.83	17.51	18.69	3.89	3.38
	27.8		26.5		15.57		40.35		18.97		4.33	
	38.5		37.0		22.53		35.98		17.35		3.36	
978	26.9	27.5	25.8	26.3	14.71	15.21	39.92	40.09	18.70	19.45	4.32	4.28
	43.9		42.4		28.53		36.49		18.54		3.95	
981	31.3	30.7	30.1	29.5	19.80	19.36	43.46	43.79	20.57	20.65	5.06	5.43
	36.1		34.6		21.76		38.52		19.53		4.39	
804	29.2	31.8	28.0	31.8	14.47	17.09	35.14	36.70	17.41	18.25	3.64	4.31
	39.5		38.1		31.37		48.09		25.00		5.76	

906	31.5	29.7	30.2	28.5	17.88	17.13	38.88	40.64	19.43	18.39	4.41	4.99
964	21.2	18.0	20.2	17.1	11.08	9.20	41.25	42.06	19.46	21.11	4.27	3.96
878	27.5	24.8	26.4	23.7	14.16	13.11	37.29	39.82	18.98	19.61	3.70	4.08
	20.8		19.8		7.92		30.19		15.42		2.77	
	34.7		33.2		14.97		28.22		14.70		2.85	
860	27.0	26.50	25.9	25.4	13.56	13.57	36.60	37.61	18.30	18.36	3.72	3.61
951	31.4	29.9	30.1	28.5	17.13	15.96	37.36	37.50	18.13	18.03	4.28	3.67
	34.1		32.7		21.77		42.09		19.86		4.64	
	20.1		19.3		11.46		45.54		21.88		4.44	
1098	16.2	19.1	15.4	18.1	8.56	10.55	44.29	44.70	20.90	21.26	4.95	4.96
	22.8		21.8		12.14		41.12		19.45		4.04	
1041	22.3	23.3	21.3	22.2	12.33	13.22	42.92	43.55	20.26	20.72	4.61	4.41
	29.7		28.4		16.85		39.90		18.56		5.17	
972	26.5	27.0	25.3	25.8	13.65	14.37	37.93	38.85	18.90	19.99	3.82	3.78
963	31.5	26.1	30.1	24.9	6.50	13.13	35.15	37.17	17.21	19.96	3.93	3.62
	30.8		29.4		16.39		36.91		18.48		3.37	
991	27.9	27.6	26.7	26.3	15.86	15.52	41.06	40.79	19.73	20.41	4.38	4.38
	33.1		32.0		18.94		38.24		19.42		4.16	
1174	26.9	27.1	25.6	25.9	16.15	17.22	43.88	46.26	20.44	22.77	5.02	5.06
	31.4		30.1		21.91		47.78		22.74		5.08	
1200	23.6	21.8	22.4	20.6	13.45	12.32	43.47	44.25	22.41	21.66	4.38	5.24
	36.7		35.2		24.59		42.43		20.95		4.03	
960	36.6	32.1	35.1	30.8	22.11	18.76	38.30	39.67	19.17	20.19	4.04	3.65
888	24.5	24.7	23.5	23.6	12.34	12.74	37.99	38.88	18.30	19.12	4.33	4.27
1032	37.8	36.1	36.3	34.6	24.03	22.69	39.51	40.13	19.10	20.11	4.98	4.58
	34.7		33.3		19.41		36.53		17.79		4.05	
754	36.3	34.8	34.8	33.5	17.73	17.67	31.18	33.10	16.04	16.62	3.16	3.53
	25.6		24.5		13.85		40.15		18.88		4.56	
1064	44.3	41.4	42.7	39.8	33.49	29.25	42.10	41.39	19.44	19.25	5.27	4.88
	27.6		26.4		14.77		38.75		18.93		4.23	
	30.2		28.7		14.26		33.01		16.55		3.15	
947	37.0	35.2	35.6	33.7	21.69	19.64	36.86	36.22	17.93	17.84	4.22	3.83
	29.9		28.6		16.99		39.83		18.65		4.24	
	18.9		17.8		10.02		42.95		21.35		4.66	
1146	32.8	35.3	31.4	33.8	21.40	24.09	43.86	44.23	21.10	21.33	5.08	4.74
950	30.5	26.8	29.1	25.5	15.61	13.53	35.62	37.03	17.78	17.93	3.73	4.05
1199	33.8	39.1	32.4	37.5	23.97	28.43	46.88	44.28	21.72	21.37	5.69	5.05

1139	24.0	19.5	22.9	18.6	15.05	11.80	47.77	48.64	22.96	21.79	4.90	5.37
	33.6	-	32.3		18.41	-	36.43		18.05		4.01	
796	38.8	39.0	37.5	37.7	22.77	23.73	35.93	37.10	17.39	18.14	3.99	3.98
	33.8		32.3		20.17		39.55		19.25		3.97	
1140	32.3	28.8	30.8	27.5	21.76	19.24	45.70	47.63	22.81	22.33	4.64	4.96
	27.8		26.7		13.94		36.11		17.52		3.94	
1175	34.2	33.0	32.7	31.6	23.38	22.41	44.98	45.44	22.42	21.04	5.19	5.41
1110	17.8	19.7	16.9	19.7	10.41	12.20	48.11	46.77	13.22	22.29	5.56	5.25
869	21.4	19.6	20.4	18.7	10.56	9.86	38.80	40.44	18.86	20.16	3.83	4.11
	35.9		34.3		21.35		38.16		19.34		4.07	
1153	23.9	27.3	22.8	26.0	14.96	17.07	47.67	45.54	21.93	21.68	5.55	4.96
1060	30.7	30.6	29.4	29.3	19.14	19.53	43.20	44.23	20.49	21.73	4.73	4.96
	23.6		22.5		12.41		40.17		19.19		4.33	
1063	23.3	24.80	22.3	23.6	13.32	14.03	43.73	42.51	21.56	20.71	4.55	4.37
895	29.6	27.1	28.4	25.9	15.83	13.86	37.60	37.21	17.26	17.39	4.74	4.60
1136	30.6	35.0	29.2	33.4	18.78	21.84	42.65	40.58	20.28	20.17	5.49	4.94
	31.2		29.9		19.81		43.57		20.42		5.25	

LTM legs	LTM legs2	Appen_1	Appen_2	FM_tr	FM_tr2	FM_arms	FM arms2	FM legs	FM legs2	FM_per1	FM_per2	VO2_I1
LTM legs	LTM legs2	.ean.Appen_	.ean.Appen_	FM_tr	FM_tr2	FM_arms	FM arms2	FM legs	FM legs2	FM_append1	FM_append2	VO2_I1
14.58		18.98		9.60		2.34		10.14		12.47		1.800
15.10	15.81	19.36	20.32	9.49	11.57	1.63	2.64	10.75	12.81	12.38	15.45	2.039
14.08		18.55		5.26		1.22		7.73		8.95		1.543
13.98		17.78		7.51		1.46		7.87		9.34		1.996
12.35		16.04		3.63		0.47		3.37		3.84		1.997
13.02		16.39		1.98		0.54		3.95		4.49		1.651
13.37	13.04	17.70	16.74	3.82	4.21	0.96	0.95	5.98	6.11	6.94	7.06	2.037
14.91		18.79		6.25		1.00		7.03		8.03		2.058
13.27	14.54	17.73	19.13	6.08	5.05	1.89	1.06	6.18	5.27	8.07	6.33	1.962
14.47	13.67	18.88	17.63	4.62	4.93	0.77	0.71	5.24	5.23	6.01	5.93	1.800
11.88	10.87	15.64	14.35	6.04	6.52	1.43	1.11	4.66	4.14	6.10	5.25	1.800
12.81	13.44	17.56	18.10	7.89	6.99	1.94	1.56	7.04	6.22	8.98	7.78	1.800
17.91		22.82		2.34		0.61		4.30		4.91		1.800
12.74	12.63	16.55	16.24	9.84	11.02	1.98	1.87	6.60	6.44	8.58	8.31	1.833
16.67	15.93	21.54	20.63	6.18	6.94	1.45	1.39	6.74	6.58	8.19	7.97	1.800
14.04		18.46		6.46		2.35		8.34		10.69		1.800
13.05	13.89	17.22	18.42	7.52	8.45	0.99	1.32	6.85	7.82	7.85	9.15	1.800
15.64	15.89	20.56	21.13	3.53	4.49	1.26		6.27	6.34	7.53	6.34	1.800
15.46	15.57	19.70	19.65	8.58	8.63	1.61	1.64	7.86	8.70	9.47	10.35	2.433
12.60		16.74		3.85		0.90		4.14		5.05		1.800
11.14	12.57	14.41	16.54	3.49	4.26	0.46	0.82	4.39	5.24	4.85	6.06	1.800
16.28		21.63		14.30		3.43		10.46		13.89		1.800
12.73	14.27	17.28	18.64	4.44	3.51	0.95	0.87	5.12	4.88	6.07	5.75	1.899
13.33	13.17	17.41	17.02	4.25	5.25	1.47	1.06	7.70	8.08	9.17	9.14	1.800
13.36		17.99		8.36		1.98		6.23		8.21		2.364
12.73	12.28	16.94	16.07	4.95	4.66	1.23	1.04	4.48	4.34	5.71	5.38	2.537
12.29	11.40	16.18	14.78	4.69	5.31	1.38	1.00	4.32	4.09	5.70	5.09	1.800
14.96		19.29		5.74		1.26		7.17		8.43		1.800
13.16		16.52		10.49		1.94		8.73		10.67		1.452
14.07	13.72	18.39	18.00	6.75	6.93	1.03	1.04	5.75	5.97	6.78	7.01	1.800
11.93		15.88		12.45		2.31		11.83		14.14		1.455
15.94	15.20	21.00	20.63	7.72	7.82	1.76	2.31	9.00	7.98	10.76	10.29	2.294
12.63		17.02		9.99		1.56		8.66		10.22		2.132
11.80	11.97	15.43	16.28	6.38	6.70	1.14	1.62	6.62	7.35	7.77	8.97	2.231
14.80		20.57		15.96		3.82		9.99		13.81		1.800

12.57	13.98	16.98	18.96	8.66	7.79	2.06	2.14	6.09	6.09	8.14	8.23	1.892
14.81	14.37	19.08	18.33	4.00	3.30	0.90	0.74	5.12	4.19	6.02	4.93	2.500
11.75	13.10	15.45	17.18	6.49	5.59	1.24	1.15	5.30	5.25	6.53	6.40	2.015
9.41		12.17		4.25		0.82		2.25		3.06		1.800
8.28		11.13		7.60		1.60		4.54		6.14		1.779
11.88	12.60	15.61	16.20	5.60	5.62	1.16	1.17	5.71	5.55	6.86	6.72	1.762
12.34	13.31	16.62	16.97	7.23	6.50	1.62	1.42	6.82	6.68	8.44	8.10	1.800
15.32		19.96		8.88		2.41		8.98		11.39		1.800
21.88		26.31		4.38		0.84		5.71		6.54		1.800
15.24	15.71	20.19	20.67	3.08	3.99	0.79	0.86	3.70	4.61	4.50	5.47	2.554
14.53		18.57		5.26		0.94		5.04		5.98		2.320
15.61	16.08	20.22	20.49	4.23	4.89	4.61	1.10	5.86	5.98	10.46	7.08	2.678
13.67		18.83		6.65		1.66		7.23		8.89		1.800
12.44	12.23	16.26	16.01	6.53	7.22	1.37	1.18	4.98	4.85	6.35	6.03	1.782
11.22	11.64	15.15	15.27	6.50	5.42	1.39	1.06	6.73	5.43	8.11	6.50	1.831
12.70		16.07		6.95		1.14		6.89		8.03		1.659
14.25	13.35	18.63	17.73	6.91	7.30	1.90	1.78	5.94	5.41	7.84	7.19	1.800
12.42		16.58		8.51		1.58		7.66		9.24		1.800
15.65	15.88	20.66	20.94	6.43	6.79	1.49	1.55	6.92	7.41	8.41	8.97	2.868
17.09		22.17		9.42		1.81		9.18		10.99		2.413
13.26	14.41	17.64	19.65	6.71	5.35	0.96	1.24	4.71	4.76	5.67	6.00	3.002
15.21		19.25		11.30		1.97		9.82		11.79		3.017
12.69	13.32	16.73	16.97	10.29	9.12	2.16	1.63	8.18	6.81	10.34	8.44	2.190
12.72	12.84	17.05	17.10	5.75	5.46	1.07	1.31	4.55	4.94	5.62	6.25	2.264
13.00	13.16	17.98	17.74	10.03	9.54	3.36	2.47	8.97	8.90	12.33	11.38	1.800
12.18		16.23		9.48		1.73		6.86		8.59		1.800
10.28	10.93	13.44	14.46	7.32	7.68	1.44	1.39	7.42	7.16	8.86	8.55	1.630
14.01		18.57		5.06		1.35		6.12		7.48		1.800
15.45	15.38	20.72	20.26	13.73	11.61	4.04	2.91	13.80	12.96	17.83	15.88	2.863
12.81		17.04		6.30		2.02		5.36		7.38		1.800
10.73		13.88		6.44		1.30		5.37		6.67		1.573
12.34	12.48	16.56	16.30	9.38	8.56	2.52	2.05	8.22	7.67	10.74	9.72	1.800
14.30		18.54		6.36		2.37		6.96		9.33		1.800
13.94		18.60		4.53		0.73		3.91		4.64		1.660
15.24	16.11	20.31	20.84	6.76	9.83	2.29	2.28	8.87	10.30	11.15	12.58	1.800
12.09	12.76	15.82	16.81	5.53	4.57	1.09	0.84	7.38	6.63	8.47	7.46	2.350
16.62	15.17	22.31	20.22	10.45	13.59	2.76	2.98	9.12	10.13	11.88	13.10	2.138

16.97	18.68	21.87	24.05	5.94	4.07	1.10	0.83	6.59	5.61	7.69	6.44	3.466
12.15		16.16		8.14		1.63		7.31		8.94		1.800
12.72	13.33	16.72	17.31	9.43	10.21	2.77	2.31	9.26	9.89	12.04	12.20	1.800
13.71		17.68		9.58		1.98		7.25		9.23		2.255
13.31	18.22	17.95	23.18	8.54	6.90	1.41	1.16	9.91	9.47	11.33	10.62	2.513
12.22		16.16		6.16		1.28		5.42		6.70		1.800
14.93	16.63	20.11	22.04	9.96	8.34	2.24	2.64	9.47	9.71	11.71	12.35	2.768
16.35	16.21	21.92	21.46	4.26	5.10	0.89	1.00	4.32	5.03	5.20	6.03	1.800
13.49	13.53	17.32	17.64	3.95	3.98	0.85	0.83	4.72	4.20	5.57	5.03	2.389
12.58		16.66		9.88		1.65		8.34		9.99		0.000
18.13	16.85	23.68	21.82	4.72	6.01	1.45	1.44	7.13	7.85	8.58	9.30	3.158
15.21	14.75	19.94	19.71	8.21	9.21	2.06	2.07	7.49	6.96	9.55	9.03	2.851
13.87		18.20		5.10		1.12		5.13		6.25		2.210
14.46	14.34	19.01	18.72	5.66	6.06	1.15	1.13	5.34	5.57	6.49	6.70	2.931
13.21	12.79	17.95	17.39	6.73	6.00	1.51	1.27	6.43	5.53	7.94	6.80	2.066
14.28	12.99	19.76	17.94	8.66	10.68	1.91	2.33	7.05	7.55	8.96	9.87	2.186
15.80		21.04		6.93		2.68		8.61		11.29		2.626

VO2_l2	V02_kg1	VO2_kg2	max hr	max hr2	max RQ	max RQ2	LTA	LTA2	VO2_1	VO2_2	VCO2_1	VCO2_2
VO2_l2	V02_kg1	VO2_kg2	max hr	max hr2	max RQ	max RQ2	LTA	LTA2	VO2_1	VO2_2	VCO2_1	VCO2_2
	26.59		180		1.05		123		206.0		176.0	
2.245	29.90	30.76	187	185	1.09	1.09			219.0	261.0	201.0	221.0
	27.80		192		1.15				207.0		166.0	
	32.50		192		1.28				211.0		184.0	
	42.40		190		1.12							
	36.60		187		1.13				172.0		154.0	
2.101	38.80	39.71	180	179	1.13	1.08			183.0	147.0	166.0	134.0
	34.30		194		1.25				208.0		167.0	
2.171	35.10	38.90	182	183	1.22	1.22			185.0	206.0	158.0	175.0
2.151	36.55	38.90	211	212	1.13	1.10	269	304	194.0	188.0	160.0	158.0
2.020	42.80	40.80	200	206	1.13	1.10	388		176.0	171.0	147.0	159.0
2.184	32.38	36.40	200	199	1.16	1.16		116	179.0	196.0	151.0	165.0
	53.95		206		1.13				236.0		191.0	
2.133	29.90	34.30	183	170	1.15	1.16	215		203.0	198.0	174.0	171.0
3.135	44.34	48.30	188	179	1.14	1.20	281		235.0	231.0	181.0	188.0
	47.91		193		1.14				225.0		191.0	
2.379	41.24	39.20	201	210	1.15	1.18	443	239	170.0	185.0	152.0	165.0
	35.70	not ava.	195	not ava.	1.21	not avail.	605	1300	223.0	228.0	185.0	189.0
2.756	36.70	41.50	not avail.	173	1.16	1.16	1300	378	213.0	213.0	176.0	175.0
	51.49		193		1.22				164.0		146.0	
1.871	35.24	35.70	201	196	1.16	1.09			177.0	208.0	152.0	184.0
	37.10		180		1.15		406		222.0		193.0	
	35.50		197		1.11				202.0	197.0	165.0	164.0
1.988	35.93	35.00	208	188	1.09	1.22		190	184.0	222.0	150.0	177.0
	37.00		212		1.12		345		196.0		160.0	
-	46.90		190		1.17				217.0	211.0	166.0	176.0
1.883	36.11	38.20	191	177	1.12	1.22			150.0	174.0	132.0	160.0
	40.47		184		1.13		527		196.0		168.0	
	23.50		190		1.15				197.0		178.0	
2.522	47.60	42.60	196	193	1.16	1.13	370	115	187.0	193.0	165.0	163.0
	21.40		179		1.18		42		198.0		178.0	
	34.40		191		1.11		220	198	234.0	216.0	194.0	186.0
	33.90		183		1.08				216.0		184.0	
2.149	42.10	37.90	210	199	1.12	1.10	316	199	191.0	213.0	156.0	179.0
	27.98		173		1.19				244.0		220.0	

2.051	31.80	32.87	197		1.08		237	435	206.0	213.0	173.0	187.0
2.686	44.10	50.30	190	191	1.18	1.16	704	234	202.0	210.0	166.0	176.0
2.764	36.50	49.90	196	196	1.18	1.17	90	143	177.0	211.0	157.0	182.0
	46.88		188		1.19		493		142.0		123.0	
	38.50		213		1.04				161.0		136.0	
2.085	32.75	38.90	193	183	1.06	1.13	0	163	205.0	159.0	170.0	178.0
2.918	42.51	51.10	197	197	1.13	1.11	478		195.0	195.0	165.0	171.0
	45.40		190		1.20		790		181.0		166.0	
	53.10		195		1.14				203.0		164.0	
2.910	46.10	50.70	201	200	1.15	1.11			199.0	193.0	167.0	159.0
	41.50		194		1.23				184.0		164.0	
2.956	46.50	50.10	187	187	1.12	1.18	281	366	192.0	220.0	159.0	172.0
	31.13		184		1.09		516		188.0		161.0	
1.487	32.40	26.80	180	194	1.08	1.08			204.0	214.0	172.0	184.0
1.858	33.90	34.80	193	198	1.22	1.20	724	727	181.0	169.0	151.0	146.0
	30.00		177		1.21				187.0		164.0	
2.299	37.24	38.70	192	192	1.15	1.15	256	247	201.0	209.0	163.0	172.0
	28.50		171		1.21		604		187.0		171.0	
2.653	45.10	40.20	170	168	1.15	1.09	486	383	217.0	227.0	188.0	182.0
	32.70		201		1.16		294		231.0		211.0	
2.245	50.20	41.34	190	192	1.13	1.06	736	703	216.0	226.0	181.0	184.0
	42.80		184		1.18				213.0		193.0	
2.023	36.25	32.90	195	188	1.15	1.12	50	54	198.0	180.0	177.0	159.0
2.369	43.80	43.70	200	200	1.12	1.19	367		210.0	194.0	176.0	158.0
2.245	35.14	37.29	186	188	1.15	1.05	223	340	227.0	246.0	186.0	221.0
	33.79		190		1.12		205		201.0		177.0	
1.660	32.40	31.44	190	191	1.16	1.13	113	91	208.0	215.0	173.0	174.0
	35.95		182		1.19				189.0		159.0	
2.701	36.70	36.30	188	185	1.19	1.12	678	94	195.0	210.0	176.0	184.0
	38.11		190		1.10		266		209.0		165.0	
	30.90		194		1.27				170.0		149.0	
2.704	41.12	44.70	191	190	1.07	1.16	261	154	189.0	192.0	169.0	166.0
	44.51		190		1.16				210.0		180.0	
	29.70		185		1.32				207.0		1.8	
2.949	41.94	40.40	181	189	1.08	1.11	480	125	227.0	234.0	183.0	191.0
2.165	43.20	40.10	186	184	1.15	1.17	136	179	197.0	157.0	155.0	133.0
2.316	30.80	30.00	200	170	1.19	1.15	561	1335	233.0	249.0	192.0	195.0

3.793	52.20	58.90	188	179	1.16	1.18	377	462	222.0	208.0	180.0	176.0
	33.62		222		1.18		330		204.0		173.0	
1.606	27.80	25.10	187	167	1.12	1.02	342	83	189.0	206.0	167.0	169.0
	35.80		196		1.13		100		197.0		176.0	
2.396	35.80	34.04	189	186	1.18	1.15		499	216.0	211.0	182.0	188.0
	43.05		183		1.10		273		189.0		157.0	
2.925	39.60	41.20	173	178	1.19	1.11	530	996	225.0	205.0	178.0	170.0
2.385	43.05	38.90	189	192	1.25	1.22	658		206.0	193.0	176.0	167.0
2.359	44.90	44.10	199	193	1.12	1.09	487	276	189.0	191.0	158.0	167.0
									189.0		154.0	
2.937	49.04	44.50	196	187	1.14	1.11		176	231.0	220.0	188.0	188.0
2.719	44.00	40.70	192	184	1.14	1.15	645	228	220.0	226.0	190.0	198.0
	40.40		205		1.22				176.0		159.0	
2.637	48.60	43.80	184	177	1.08	1.14	147		196.0	227.0	166.0	188.0
2.463	36.90	43.60	190		1.07	1.08	550	490	189.0	189.0	160.0	166.0
2.022	35.20	30.50	191	188	1.12	1.05	586	679	207.0	200.0	159.0	164.0
	39.20		190		1.16		301		267.0		220.0	

RMR_1	RMR_2	RQ	RQ2	M_abs1	M_corr1	M_abs2	M_corr2	M_FFM1	M_FFM2	Ins_1	Ins_2	Chol_1
RMR_1	RMR_2	RQ	RQ2	M_abs1	M_corr1	M_abs2	M_corr2	M_FFM1	M_FFM2	Ins_1	Ins_2	Chol_1
1420.0		0.85		642.9	654.7			16.33		109.00		158
1530.0	1780	0.92	0.81	339.4	345.5	500.29	515.44	8.29	12.36	50.87	71.23	
1400.0		0.80		341.6	347.7			9.29		72.00		251
1460.0		0.87		352.3	326.3			8.28				182
1120.0				480.0	445.1			11.87				156
1190.0		0.90		282.8	261.7			7.11				178
1270.0	1020.0	0.91	0.92	365.4	371.9	442.95	456.34	9.91	12.32	85.27	71.50	199
1410.0		0.80		434.6	402.8			9.66				
1270.0	1420.0	0.86	0.85	325.9	331.6	423.00	435.79	8.68	10.69	68.30	83.00	172
1320.0	1290.0	0.82	0.84	344.3	350.4	385.53	397.17	8.67	9.79	69.90	123.00	157
1200.0	1190.0	0.83	0.93	503.3	512.5	504.00	519.26	14.86	15.06	88.00	91.00	176
1220.0	1340.0	0.85	0.84	305.7	311.1	374.60	385.90	8.09	9.34	77.60	76.90	193
1610.0		0.81		505.9	515.1			11.11		50.96		137
1400.0	1370.0	0.85	0.86	326.5	332.3	407.95	420.27	8.58	10.57	57.83	74.30	173
1580.0	1570.0	0.77	0.82	451.3	459.5	436.70	449.90	9.97	9.69	78.00	71.00	159
1540.0		0.85		377.0	383.7			9.98		66.17		217
1180.0	1280.0	0.89	0.90	395.4	402.5	425.91	438.78	10.47	11.16	85.00	63.23	163
1530.0	1560.0	0.83	0.83	522.7	532.2	482.00	496.59	12.38	11.59	88.00	65.00	157
1450.0	1450.0	0.83	0.82	309.4	314.9	454.28	468.02	7.34	11.26	66.23	81.27	230
1130.0		0.89		328.1	333.9			8.37		106.00		118
1220.0	1440.0	0.85	0.89	310.0	315.5	305.37	314.55	9.14	8.26	57.83	49.97	182
1540.0		0.87		298.7	304.0			6.39		74.93		196
1370.0	1350	0.82	0.83	279.4	284.3	345.29	355.70	7.18	8.95			196
1250.0	1510.0	0.82	0.79	592.4	603.2	583.54	601.24	16.39	15.79	86.90	63.43	167
1330.0		0.82		191.4	194.6			4.82		78.00		167
1460.0	1440.0	0.77	0.84	353.3	359.6	_	_	9.13	_	57.00		165
1030.0	1210.0	0.88	0.92	336.1	342.1	316.27	325.79	9.46	9.09	54.00	57.70	167
1350.0		0.86		375.9	382.6			9.48		69.00		144
1370.0		0.90		222.2	205.4			5.71				176
1290.0	1320.0	0.88	0.84	458.9	467.2	452.54	466.23	11.71	11.63	85.40	100.47	165
1380.0		0.90		246.9	228.3			6.26				190
1600.0	1490.0	0.83	0.86	480.0	488.7	516.00	531.63	11.25	12.14			201
1490.0		0.85		297.4	302.6			7.86				198
1300.0	1460.0	0.82	0.84	458.1	466.4	329.70	339.63	13.27	9.25	103.00	93.00	189
1700.0		0.90		610.4	621.6			12.93		84.03		228

1410.0	1480.0	0.84	0.88	283.7	288.7	325.04	334.83	7.42	8.24	73.97	70.67	178
1380.0	1440.0	0.82	0.84	530.9	540.6	456.84	470.66	13.10	11.19			133
1230.0	1450.0	0.88	0.86	246.1	250.4	287.11	295.74	6.72	7.43			177
970.0		0.87		379.4	386.2			12.79		66.20		153
1115.0		0.85		219.0	222.8			7.89		78.00		204
1400.0	1160	0.83	1.13	408.9	419.6	558.71	518.3	11.46	13.78			199
1340.0	1350.0	0.85	0.87	482.0	490.8	550.71	567.40	13.14	15.13	64.93	86.70	184
1260.0		0.92		66.9	67.8			1.61		57.00		206
1380.0		0.81		481.0	489.7			10.75		79.47		155
1365.0	1320.0	0.84	0.83	489.0	497.9	550.26	566.94	11.24	12.68			166
1270.0		0.89		216.0	199.5			4.85				228
1310.0	1480.0	0.83	0.78	514.3	523.6	279.42	287.81	12.20	6.61	84.93	76.97	245
1290.0		0.85		378.0	384.8			9.64		91.13		146
1400.0	1470.0	0.84	0.86	432.9	444.3	432.86	401.2	11.71	10.33			183
1230.0	1160.0	0.84	0.87	303.4	308.8	406.00	418.27	8.78	11.25	73.00	122.00	153
1290.0		0.88		480.0	445.1			12.06				
1360.0	1442.0	0.81	0.82	411.9	419.3	358.71	369.53	10.21	9.06		60.20	162
1300.0		0.91		414.4	421.9			11.03		74.20		141
1500.0	1540.0	0.86	0.80	445.6	453.6	574.26	591.68	10.34	12.79	59.10	56.60	167
1610.0		0.91		805.0	819.9			17.16				128
1480.0	1540.0	0.84	0.82	519.7	529.2	536.58	552.84	12.17	12.49	56.23	51.33	184
1490.0		0.91		574.9	533.3			12.57				
1370.0	1250.0	0.89	0.88	263.1	269.3	231.42	213.9	7.03	5.39			181
1440.0	1320.0	0.84	0.81	615.7	627.0	660.14	680.18	16.50	17.50	70.00	80.00	209
1550.0	1720.0	0.82	0.90	444.6	452.6	670.29	690.64	11.46	17.21	70.17	89.73	222
1390.0		0.88		326.4	332.2			9.09		74.40		232
1420.0	1460.0	0.83	0.81	219.3	223.1	219.43	225.98	7.16	6.83	58.37	77.57	228
1290.0		0.85		494.7	503.7			12.54		62.20		183
1360.0	1450.0	0.91	0.88	572.9	583.3	516.00	531.63	13.86	12.84	85.33	79.30	174
1410.0		0.79		372.7	379.4			9.79		48.00		191
1170.0		0.88		380.6	352.6			10.68				188
1310.0	1320.0	0.90	0.87	463.4	471.8	459.68	473.59	12.80	13.08	60.70	65.10	157
1450.0		0.86		537.7	547.5			13.75		79.00		
1.4		0.88		258.4	239.0			5.56				
1540.0	1600.0	0.80	0.82	367.4	374.0	894.84	830.9	8.53	18.79	60.70	65.10	156
1340.0	1070.0	0.79	0.85	358.1	364.5	438.86	452.13	10.23	12.21	80.93		
1596.0	1680.0	0.82	0.78	727.3	740.7	577.69	595.21	15.80	13.44	94.57	70.27	180

1510.0	1430.0	0.81	0.84	454.7	462.9	645.40	664.99	9.69	13.67	87.00	74.00	165
1400.0		0.85		325.9	331.6			9.10		87.07		
1310.0	1400.0	0.89	0.83	256.1	260.6	239.98	247.16	7.25	6.66	78.63	77.73	292
1385.0		0.89		321.4	327.1			8.27				191
1480.0	1470.0	0.85	0.89	485.8	494.6	525.41	541.33	10.82	11.37			
1290.0		0.83		329.0	334.8			9.27				206
1530.0	1470.0	0.79	0.83	522.8	537.0	742.28	689.0	11.94	15.16			146
1420.0	1330.0	0.85	0.87	727.0	740.4	719.99	741.87	15.39	15.86	61.00	71.30	194
1290.0	1320.0	0.84	0.88	376.4	383.2	519.00	534.72	9.88	13.22	93.00	103.00	179
1280.0		0.82		480.4	445.5			11.68				175
1570.0	1510.0	0.81	0.86	573.0	588.8	509.14	472.2	12.35	10.37			191
1520.0	1570.0	0.86	0.87	411.4	422.2	407.99	378.1	9.77	8.55			207
1220.0		0.91		469.9	478.4			11.91		76.00		151
1340.0	1550	0.84	0.83	262.3	268.4	421.70	390.9	6.14	9.20			171
1300.0	1300.0	0.85	0.88	363.0	369.5	340.27	350.52	9.83	9.42	97.13	98.03	184
1390.0	1360.0	0.77	0.82	395.7	402.8	252.40	259.96	9.45	6.41	102.00	92.00	188
1830.0		0.82		353.1	359.4			8.25				231

Trig_1	HDL_1	LDL_1	Ch_HDL1	ins_0	ins_120	glu_0	glu_120	L2sc_1	L2sc_2	L2vis_1	L2vis_2	L4sc_1
Trig_1	HDL_1	LDL_1	Ch_HDL1	ins_0	ins_120	glu_0	glu_120	L2sc_1	L2sc_2	L2vis_1	L2vis_2	L4sc_1
58	64		2.47	5.6	50.5	99	102					
				10.2	40.8	77	72	13233.00	18061.00	1944.00	2297.00	30197.00
236	63	141	3.98	7.4	64.9	73	77	-	-	-	-	8458.00
215	54	85	3.4	6.6	36.4	79	94	13010.00		2826.00		20977.00
120	55	77	2.84			75	67	2344.00		2066.00		6604.00
66	61	104	2.92	6.0	17.2	74	72					
49	73	16	2.73	5.0	13.0	82	78	-	6493.00	-	1735.00	7809.00
134	48	97	3.58	8.5	46.7	72	69	-	5279.00	-	2175.00	12936.00
107	43	93	3.65	11.0	94.0	79	81	4207.00	5440.00	3795.00	3140.00	5440.00
81				5.0	11.0	70	51	-	11919.00	-	3155.00	14767.00
174	41	117	4.71	7.0	25.6			-	9760.00	-	4051.00	18499.00
115				5.0	38.0	77	90	-	-	-	-	2727.00
136	67	79	2.58	8.6	42.7	85	99	19509.00	20344.00	8590.00	9454.00	34578.00
93				5.0	63.0	78	89	-	7342.00	-	4712.00	17093.00
117	65	129	3.34	5.0	8.5	80	76	-	-	-	-	14333.00
68	52	97	3.13	5.0	43.1	76	101	11943.00	13876.00	3742.00	4509.00	22231.00
63				6.0	53.0	82	79	-	6884.00	-	3232.00	10042.00
153	111	88	2.07	10.1	71.0	79	111	15518.00	13625.00	2506.00	2234.00	24221.00
79				8.0	37.0	75	73	-	-	-	-	8221.00
87	62	103	2.94	5.5	55.5	75	134	4524.00	6471.00	1486.00	3101.00	7575.00
47				7.0	41.0	85	76	-	-	-	-	35004.00
87	77	102	2.55	10.0	47.6	77	133	5572.00	4470.00	2880.00	2421.00	13539.00
117	47	97	3.55	6.3	16.0	82	87	-	5457.00	-	1436.00	5306.00
119				0.0	65.0	82	79	-	15777.00	-	7282.00	-
91				7.0	18.0	83	64	-	6520.00	-	2220.00	13150.00
126	34	108	4.91	5.3	21.3	89	77	-	7792.00	-	3272.00	16136.00
82	52	76	2.77	8.7	19.1	76	73	-	-	-	-	10032.00
107	60	95	2.93									
111				7.0	39.0	87	71	-	11815.00	-	3219.00	-
84	66	107	2.90									
144	56	116	3.59	8.8	84.5	85	125	-	15791.00	-	2491.00	27896.00
105	37	140	5.35	8.5	113.8	74	124	17743.00	-	2360.00	-	21360.00
188				10.0	49.0	85	88	-	7884.00	-	3438.00	-
138	53	147	4.30	13.2	26.8	94	79	-	-	-	-	36987.00

121	69	85	2.58	10.8	62.3	85	85	11869.00	11992.00	5291.00	5265.00	22683.00
62	50	71	2.66	5.0	31.9	83	104	4807.00	3847.00	1779.00	1616.00	13065.00
71	52	111	3.40	5.0	61.0	76	114	7904.00	7484.00	4852.00	3416.00	19810.00
52	66	77	2.32	5.0	8.3	70	57	9131.00	-	3397.00	-	17414.00
88	60	126	3.40	5.8	25.8	89	103	12612.00	-	5037.00	-	23255.00
60	60	127	3.32	6.1	63.7	73	101	9407.00		4036.00		20798.00
106				7.1	59.4	87	104	-	12292.00	-	3587.00	-
105				5.0	27.0	74	62	-	-	-	-	16170.00
45	61	85	2.54	5.0	15.4	76	67	-	-	-	-	9490.00
61	59	95	2.81	5.0	41.8	80	102	4958.00	5102.00	2061.00	3415.00	9809.00
95	64	145	3.56	8.1	18.4	77	87	6827.00		2786.00		14192.00
73	52	178	4.71	7.8	30.0	84	74	3988.00	4844.00	1591.00	2683.00	8120.00
76	49	82	2.98	5.0	8.0	84	79	7572.00	-	3233.00	-	23822.00
138	57	98	3.21	8.3	48.2	81	78	12333.00	3266.00	2782.00	2368.00	17972.00
110				9.0	23.0	80	88	-	7601.00	-	3061.00	14324.00
71	71	77	2.28	5.0	13.0	64	87	13222.00	13678.00	3651.00	4219.00	27723.00
53				12.2	96.9	80	124	11677.00	-	7726.00	-	24784.00
61	66	89	2.53	5.0	13.0	82	64	7872.00	9642.00	4260.00	5854.00	12513.00
30	60	62	2.13	12.9	29.5	84	91	10725.00	-	5794.00	-	25894.00
108				6.0	14.0	79	66	-	10623.00	-	3391.00	13871.00
						72	93					
73	54	112	3.35	14.8	153.6	69	111	11920.00	97.96	7762.00	71.15	21480.00
97				5.0	18.0	77	74	-	11508.00	-	2915.00	12756.00
132	74	122	3.00	6.2	27.2	85	75	19182.00	14936.00	5417.00	4563.00	34014.00
70	52	166	4.46	5.8	74.6	87	125	12944.00	-	6342.00	-	17753.00
117	69	136	3.30	8.7	64.8	86	98	10060.00	9829.00	2133.00	2981.00	20270.00
81				6.0	51.0	81	96	-	-	-	-	11766.00
111				12.0	45.0	82	76	-	17521.00	-	4344.00	-
65	45	133	4.24	5.4	14.3	83	58	10955.00	-	5125.00	-	24819.00
82	62	110	3.03									
123				6.1	21.5	80	86	-	12698.00	-	4425.00	27934.00
64				5.0	18.0	68	74	-	-	-	-	21250.00
						71	82					
113	48	85	3.25	5.0	21.8	82	103	15136.00	18210.00	2694.00	4099.00	-
					45.4	80	67	6347.00	5186.00	3467.00	3063.00	10868.00
83				12.0	22.0	87	75	-	18482.00	-	6848.00	17056.00

33				5.0	40.0	73	78	-	3822.00	-	2104.00	15832.00
				7.7	101.4	90	98	10572.00	-	4697.00	-	15822.00
75	77	200	3.79	6.4	58.0	92	111	17852.00	17978.00	4542.00	6105.00	29532.00
68	55	122	3.47	5.8	80.1	81	112	15903.00	-	4763.00	-	22778.00
				5.0	32.1	79	78	8819.00	7616.00	2413.00	2340.00	24254.00
173	58	113	3.55	10.1	77.3	84	102	8460.00	-	3493.00	-	17685.00
84	57	72	2.56	8.7	35.6	74	65	12532.00	11622.00	2518.00	2013.00	24624.00
121				5.0	17.0	86	69	5315.00	6710.00	3237.00	4549.00	9813.00
						78.00	75.00					
73				5.0	11.3	90	51	-	5465.00	-	2602.00	6684.00
80	59	100										
143	57	105	3.35	5.2		72	69	3352.00		2185.00		8336.00
65	48	146	4.31	8.1	105.1	78	120	12668.00	13227.00	4806.00	4628.00	22460.00
59				5.0	33.0	81	72	-	-	-	-	12703.00
88	53	100	3.23	9.1	81.3	75	107	8645.00	7755.00	2086.00	1702.00	15289.00
81	39	129	4.72	6.0	37.0			9462.00	9280.00	4944.00	4500.00	18400.00
98				9.0	71.0	79	76	-	20561.00	-	6172.00	18675.00
95	67	145	3.45	10.3	32.0	80	68	13606.00		1497.00		-

L4sc_2	L4vis_1	L4vis_2	RTatt_1	RTatt_2	LTatt_1	LTatt_2	Avatt_1	Avatt_2	RTarea_1	RTarea_2	LTarea_1	LTarea_2
L4sc_2	L4vis_1	L4vis_2	LAM.Rgt_1	LAM.Rgt_2	LAM.Lft_1	LAM.Lft_2	verage.LAM_	verage.LAM_	usc.Rgt.area	usc.Rgt.area	usc.Lft.area_	usc.Lft.area_
			47.90		48.90		48.40		9789.00		10888.00	
37348.00	2536.00	3351.00	48.30	49.70	47.70	48.80	48.57	49.25	10200.00	11583.00	9865.00	11678.00
-	3474.00	-	47.00	-	47.90	-	47.45	-	9209.00	-	8969.00	-
	3364.00		51.90		50.80		51.35		10609.00		10686.00	
	1447.00		50.40		49.30		49.85		10521.00		9452.00	
12631.00	1438.00	3149.00	45.00	49.20	45.40	49.70	46.53	49.45	11472.00	9969.00	10636.00	9305.00
12935.00	2883.00	2834.00	50.50	52.80	51.40	52.90	51.57	52.85	11009.00	11553.00	10471.00	10991.00
12841.00	3140.00	3069.00	50.80	-	50.10	-	50.45	#DIV/0!	11782.00	-	11772.00	-
18821.00	3793.00	4074.00	49.80	51.30	51.30	49.40	50.80	50.35	10952.00	11379.00	10717.00	11022.00
16102.00	3979.00	4205.00	48.20	50.80	48.10	50.90	49.03	50.85	10464.00	11035.00	10192.00	10624.00
-	2023.00	-	48.80	-	50.10	-	49.45	-	13329.00	-	13162.00	-
34305.00	5791.00	7259.00	49.80	50.60	49.50	50.30	49.97	50.45	11292.00	11122.00	10728.00	11076.00
17340.00	3853.00	5078.00	-	51.50	-	49.50	51.50	50.50	-	14021.00	-	13129.00
-	2693.00	-	47.80	-	50.30	-	49.05		10785.00	-	10532.00	-
26000.00	3232.00	4426.00	46.90	52.50	47.60	51.10	49.00	51.80	15243.00	15076.00	13827.00	13616.00
12909.00	3248.00	4635.00	50.10	50.30	48.00	51.40	49.47	50.85	9785.00	10621.00	9295.00	10498.00
26059.00	4174.00	3525.00	47.60	50.20	48.30	48.40	48.70	49.30	11161.00	11936.00	11477.00	12052.00
-	1895.00	-	-	-	-	-		-	-	-	-	-
9040.00	2092.00	3024.00	47.20	51.00	47.10	50.20	48.43	50.60	7139.00	9352.00	7232.00	9481.00
-	6033.00	-	45.70	-	46.60	-	46.15	-	11582.00	-	11174.00	-
13068.00	3539.00	3299.00	51.40	51.80	49.90	51.10	51.03	51.45	10721.00	10426.00	9939.00	10336.00
-	3203.00	-	46.70	49.60	45.90	49.20	47.40	49.40	9200.00	7961.00	8452.00	7592.00
28180.00	-	6539.00	-	51.20	-	52.70	51.20	51.95	-	12106.00	-	11707.00
11976.00	3929.00	3488.00	49.80	50.60	49.10	49.70	49.83	50.15	12009.00	11659.00	10757.00	10412.00
13993.00	4288.00	4342.00	51.80	51.20	51.10	50.80	51.37	51.00	10564.00	10737.00	10143.00	10040.00
-	4467.00	-	-	-	-	-		-	-	-	-	-
21447.00	-	3439.00	-	50.80	-	50.00	50.80	50.40	-	11993.00	-	11537.00
28430.00	4451.00	4048.00	-	53.40	-	53.30		53.35	-	12924.00	-	11567.00
-	2811.00	-	50.10	-	50.20	-	50.15	-	10820.00	-	10030.00	-
17942.00	-	3091.00	-	52.90	-	52.10	52.90	52.50	-	12550.00	-	11167.00
-	8387.00	-	44.30	-	43.90	-	44.10	-	10938.00	-	10330.00	-

23964.00	7993.00	6318.00	52.30	49.90	51.60	50.80	51.27	50.35	10646.00	10469.00	10808.00	10260.00
8812.00	2400.00	2116.00	51.10	-	51.00	-	51.05	#DIV/0!	12774.00	-	12525.00	-
20239.00	4416.00	4666.00	52.50	52.40	49.80	49.80	51.57	51.10	11333.00	11341.00	11142.00	11142.00
-	3979.00	-	49.80	-	50.10	-	49.95	-	9555.00	-	9708.00	-
-	3062.00	-	51.20	-	50.60	-	50.90	-	7336.00	-	7441.00	-
	4635.00		48.00		47.90		47.95	#DIV/0!	9922.00		9875.00	
20720.00	-	3224.00	-	51.80	-	51.90	51.80	51.80	-	10045.00	-	10178.00
-	4071.00	-	-	-	-	-		-	-	-	-	-
-	2078.00	-	47.20	-	46.20	-	46.70	-	12579.00	-	13371.00	-
8433.00	3558.00	3845.00	51.70	49.90	51.40	49.80	51.00	49.85	12865.00	13159.00	12607.00	12902.00
	3530.00		53.50		52.60		53.05		10822.00		10833.00	
8053.00	3188.00	3642.00	51.10	51.00	49.20	50.40	50.43	50.70	12251.00	12768.00	12104.00	12513.00
-	4366.00	-	48.00	-	46.30	-	47.15	-	11763.00	-	11631.00	-
6486.00	2818.00	2677.00	48.50	50.70	47.50	50.00	48.90	50.35	10056.00	8790.00	10742.00	8779.00
16507.00	2294.00	2478.00	50.90	54.00	49.10	53.40	51.33	53.70	9005.00	9516.00	8751.00	9057.00
25320.00	2931.00	2572.00	50.10	50.70	50.60	50.00	50.47	50.35	12698.00	13569.00	12749.00	14083.00
-	6522.00	-	44.60	-	44.00	-	44.30	-	9673.00	-	10014.00	-
13401.00	5060.00	5558.00	46.20	49.60	45.00	49.60	46.93	49.60	12195.00	12834.00	12516.00	13422.00
-	5071.00	-	46.60	-	46.60	-	46.60	-	13128.00	-	14444.00	-
21091.00	2851.00	1907.00	47.30	48.90	46.40	49.40	47.53	49.15	13284.00	13190.00	12534.00	12689.00
21355.00	6404.00	6869.00	50.00	50.50	50.30	49.60	50.27	50.05	11571.00	10455.00	11786.00	10690.00
19587.00	2397.00	3365.00	50.20	52.80	51.40	52.70	51.47	52.75	10910.00	10395.00	11013.00	10215.00
29311.00	6173.00	4566.00	44.70	52.40	43.80	50.10	46.97	51.25	10633.00	10842.00	9918.00	10196.00
-	6708.00	-	48.40	-	47.40	-	47.90	-	10437.00	-	9294.00	-
19871.00	4316.00	4373.00	53.00	53.00	52.40	52.90	52.80	52.95	8662.00	10078.00	7935.00	9411.00
-	1658.00	-	48.50	-	48.90	-	48.70	-	10673.00	-	10941.00	-
40379.00	-	3628.00	-	49.80	-	49.80	49.80	49.80	-	10247.00	-	10487.00
-	3002.00	-	46.90	-	47.30	-	47.10	-	12066.00	-	10840.00	-
26067.00	4581.00	5332.00	44.40	52.60	43.20	50.60	46.73	51.60	9043.00	9655.00	10092.00	10734.00
-	3104.00	-	46.70	-	47.10	-	46.90	-	10370.00	-	10286.00	-
26343.00	-	4442.00	44.80	45.60	47.00	45.70	45.80	45.65	11543.00	11564.00	12649.00	12375.00
9387.00	4013.00	2809.00	50.80	-	51.40	-	51.10	#DIV/0!	9990.00	-	10042.00	-
36109.00	4862.00	7300.00	43.90	48.40	44.80	45.70	45.70	47.05	13356.00	13102.00	12511.00	12239.00

11728.00	3909.00	2599.00	-	50.90	-	49.90	50.90	50.40	-	13887.00	-	13266.00
-	5280.00	-	47.80	-	45.50	-	46.65	-	9006.00	-	8799.00	-
29838.00	4707.00	5420.00	48.30	49.30	48.70	49.00	48.77	49.15	9783.00	9827.00	9628.00	9614.00
-	4968.00	-	49.40	-	49.30	-	49.35	-	11371.00	-	11522.00	-
23851.00	4062.00	3989.00	49.20	-	49.40	-	49.30	#DIV/0!	12156.00		12482.00	
-	5192.00	-	49.50	-	51.70	-	50.60	-	11440.00	-	11959.00	-
24992.00	3707.00	3776.00	49.00	51.50	48.80	51.10	49.77	51.30	12331.00	12964.00	12479.00	12393.00
11847.00	2128.00	2079.00	45.80	49.10	44.70	47.70	46.53	48.40	16354.00	14929.00	15919.00	14589.00
9081.00	887.00	1784.00	-	51.30	-	49.30	51.30	50.30	-	12208.00	-	11826.00
	3013.00		48.20		49.20		48.70	#DIV/0!	13286.00		13322.00	
24466.00	6281.00	5790.00	49.50	49.30	49.70	49.30	49.50	49.30	12770.00	13407.00	12124.00	12829.00
-	2985.00	-	49.40	-	50.20	-	49.80	-	12006.00	-	12098.00	-
13707.00	2573.00	1859.00	51.60	51.70	52.00	52.60	51.77	52.15	12691.00	12659.00	12584.00	12589.00
16672.00	4389.00	4503.00	48.40	52.00	49.60	51.60	50.00	51.80	11987.00	11166.00	11624.00	10946.00
36236.00	2181.00	5093.00	51.00	52.20	53.00	55.90	52.07	54.05	11158.00	9833.00	11528.00	10537.00
	-		-		-				-		-	

RTsc_1	RTsc_2	LTsc_1	LTsc_2	Thi_sc1	Thi_sc2	Thi_ar1	Thi_ar2	TEE_1	TEE_2	EEPA_1	EEPA_2	PAL_1
SubFat.Rgt_1	Sub.Fat_2	SubFat.Lft_1	SubFat.Lft_2	erage.SubFa	erage.SubFa	rage.MuscAr	erage.MuscAre	TEE_1	TEE_2	EEPA_1	EEPA_2	PAL_1
11297.00		11859.00		11578.00		10338.50	0.00	2634.8		951.31		1.86
12548.00	17591.00	11980.00	18194.00	12264.00	17892.50	10032.50	11630.50					
16779.00	-	16818.00	-	16798.50		9089.00	#VALUE!	2706.4		1035.73		1.93
12523.00		12696.00		12609.50		10647.50	0.00					
8089.00		8868.00		8478.50		9986.50	0.00					
						0.00	0.00					
12223.00	9286.00	11543.00	9213.00	11883.00	9249.50	11054.00	9637.00	2765.7	2140.02	1219.15	906.02	2.18
						0.00	0.00					
9448.00	5963.00	9273.00	5778.00	9360.50	5870.50	10740.00	11272.00	3164.5	3131.65	1578.07	1398.48	2.49
7145.00	-	6891.00	-	7018.00	#VALUE!	11777.00	#VALUE!	2726.5	2619.71	1133.82	1067.74	2.07
6627.00	7949.00	6653.00	8040.00	6640.00	7994.50	10834.50	11200.50	2539.4	2560.66	1085.44	1114.59	2.12
10419.00	6340.00	10567.00	6562.00	10493.00	6451.00	10328.00	10829.50	2272.6		825.36		1.86
6397.00	-	6417.00	-	6407.00		13245.50	#VALUE!	3829.0		1836.10		2.38
11798.00	14387.00	12801.00	14611.00	12299.50	14499.00	11010.00	11099.00					
-	8186.00	-	8195.00		8190.50	#VALUE!	13575.00	2465.0	2881.37	638.50	1023.23	1.56
12757.00	-	12722.00	-	12739.50		10658.50	#VALUE!	3308.3		1437.45		2.15
12059.00	11735.00	12257.00	11531.00	12158.00	11633.00	14535.00	14346.00	3091.8	2661.78	1602.62	1115.60	2.62
6626.00	8757.00	6687.00	9004.00	6656.50	8880.50	9540.00	10559.50	2426.6	2389.92	653.96	590.93	1.59
10624.00	12240.00	10525.00	12509.00	10574.50	12374.50	11319.00	11994.00	2691.0		971.90		1.86
-	-	-	-			#VALUE!	#VALUE!					
4704.00	6714.00	4598.00	6674.00	4651.00	6694.00	7185.50	9416.50					
18407.00	-	18811.00	-	18609.00		11378.00	#VALUE!	2388.0		609.20		1.55
6785.00	9030.00	6638.00	9077.00	6711.50	9053.50	10330.00	10381.00					
12745.00	9235.00	12840.00	9931.00	12792.50	9583.00	8826.00	7776.50	2462.0		965.80		1.97
-	7642.00	-	7139.00			#VALUE!	11906.50	2790.5		1181.41		2.10
7877.00	6013.00	8174.00	6042.00	8025.50	6027.50	11383.00	11035.50	3096.2	2624.01	1326.59	921.60	2.12
5147.00	7247.00	5716.00	7870.00	5431.50	7558.50	10353.50	10388.50	1794.0		584.64		1.74
-	-	-	-			#VALUE!	#VALUE!	2219.8		647.79		1.64
						0.00	0.00					
-	9697.00	-	9144.00		9420.50	#VALUE!	11765.00	2324.0		801.58		1.80
-	16765.00	-	16282.00		16523.50	#VALUE!	12245.50					
14129.00	-	14333.00	-	14231.00		10425.00	#VALUE!	2407.4		676.67		
-	12196.00	-	12431.00		12313.50	#VALUE!	11858.50	2177.8	2159.09	659.99	483.18	1.68
17706.00	-	16558.00	-	17132.00		10634.00	#VALUE!	3179.0		1161.08		1.87

7707.00	12098.00	7487.00	11269.00	7597.00	11683.50	10727.00	10364.50	2325.1		682.57		
8470.00	-	8021.00	-	8245.50	#VALUE!	12649.50	#VALUE!	2458.5		832.63		1.78
8757.00	9211.00	9269.00	9601.00	9013.00	9406.00	11237.50	11241.50	1996.7		567.04		1.62
5955.00	-	5259.00	-	5607.00		9631.50	#VALUE!	2233.9		1040.51		2.30
6081.00	-	6161.00	-	6121.00		7388.50	#VALUE!	1538.1		269.27		1.38
10240.00		10666.00		10453.00		9898.50	0.00					
-	8000.00	-	7793.00		7896.50	#VALUE!	10111.50	2321.1		748.99		1.73
-	-	-	-			#VALUE!	#VALUE!	2156.0		680.40		1.71
8067.00	-	8274.00	-	8170.50		12975.00	#VALUE!	3130.1		1437.13		2.27
5823.00	5880.00	5090.00	5468.00	5456.50	5674.00	12736.00	13030.50	2622.7		995.45		1.92
5182.00		5148.00		5165.00		10827.50	0.00					
6486.00	8065.00	6725.00	8111.00	6605.50	8088.00	12177.50	12640.50					
10282.00	-	10077.00	-	10179.50		11697.00	#VALUE!	1980.7		492.62		1.54
10728.00	5634.00	10062.00	5470.00	10395.00	5552.00	10399.00	8784.50					0.00
13115.00	8294.00	12459.00	8174.00	12787.00	8234.00	8878.00	9286.50	2066.7	2341.23	630.03	947.11	1.68
						0.00	0.00					
11313.00	8610.00	12471.00	8775.00	11892.00	8692.50	12723.50	13826.00	2739.8	2498.77	1105.84	806.89	2.01
11817.00	-	11736.00	-	11776.50		9843.50	#VALUE!	2397.9		858.07		1.84
8537.00	11631.00	8837.00	11664.00	8687.00	11647.50	12355.50	13128.00	3142.3		1328.10		2.09
11282.00	-	10991.00	-	11136.50		13786.00	#VALUE!	2799.4		909.45		1.74
7586.00	6985.00	7624.00	7335.00	7605.00	7160.00	12909.00	12939.50	3114.4	3094.78	1322.99	1245.30	2.10
8650.00	14504.00	8661.00	14607.00	8655.50	14555.50	11678.50	10572.50					
5990.00	5990.00	5955.00	5955.00	5972.50	5972.50	10961.50	10305.00		3493.67		1824.31	
12108.00	10261.00	12515.00	11182.00	12311.50	10721.50	10275.50	10519.00	2996.0		1146.40		1.93
7136.00	-	7477.00	-	7306.50		9865.50	#VALUE!	2064.5		468.07		1.49
9053.00	9539.00	9099.00	9947.00	9076.00	9743.00	8298.50	9744.50	1997.0		377.30		1.41
8041.00	-	8548.00	-	8294.50		10807.00	#VALUE!	2336.0		812.40		1.81
-	15841.00	-	15879.00		15860.00	#VALUE!	10367.00	2163.6	2506.04	587.25	805.43	1.59
9135.00	-	9903.00	-	9519.00		11453.00	#VALUE!	2615.9		944.32		1.86
						0.00	0.00					
16157.00	9647.00	15872.00	10199.00	16014.50	9923.00	9567.50	10194.50	3346.8	1909.24	1702.08	398.32	2.55
14143.00	-	14022.00	-	14082.50		10328.00	#VALUE!	3081.4		1323.29		2.13
14350.00	11272.00	14136.00	11787.00	14243.00	11529.50	12096.00	11969.50	2976.5		1138.83		1.93
13998.00	-	12654.00	-	13326.00	-	10016.00	-					
14028.00	11740.00	13841.00	11214.00	13934.50	11477.00	12933.50	12670.50	3029.7	3126.70	1130.70	1134.03	1.90

-	7064.00	-	7770.00		7417.00	#VALUE!	13576.50	3568.7	2309.08	1701.85	648.17	2.36
9761.00	-	9631.00	-	9696.00		8902.50	#VALUE!	2344.1		709.72		1.67
12654.00	13603.00	12537.00	13255.00	12595.50	13429.00	9705.50	9720.50	2441.2		887.05		1.86
9914.00	-	9904.00	-	9909.00		11446.50	#VALUE!					
16628.00		16800.00		16714.00	0.00	12319.00	0.00					
10222.00	-	10355.00	-	10288.50		11699.50	#VALUE!	2315.5		793.93		1.79
14314.00	14525.00	14346.00	15340.00	14330.00	14932.50	12405.00	12678.50					
7298.00	6928.00	7122.00	6499.00	7210.00	6713.50	16136.50	14759.00	2834.6		1131.17		2.00
-	6530.00	-	6238.00		6384.00	#VALUE!	12017.00	2871.3	2161.21	1294.21	625.09	2.23
						0.00	0.00					
13002.00		12033.00		12517.50		13304.00	0.00					
13065.00	12517.00	13330.00	12461.00	13197.50	12489.00	12447.00	13118.00					
9109.00	-	8471.00	-	8790.00		12052.00	#VALUE!	2584.0		1105.60		2.12
13112.00	12658.00	12996.00	12245.00	13054.00	12451.50	12637.50	12624.00					
8522.00	6893.00	8616.00	6567.00	8569.00	6730.00	11805.50	11056.00	2526.3		973.68		1.94
8844.00	8116.00	8585.00	8341.00	8714.50	8228.50	11343.00	10185.00	2219.0	2218.83	607.10	636.95	1.60
-		-										

PAL_2	Lep_1	Lep_2	En_int	Prot_g	CHO_g	Fat_g	Sat_g	Mono_g	Poly_g	Chol_mg	Fiber	Per_Pro
PAL_2	Leptine_1	Leptine_2	Caloric.Intake	Prot_g	CHO_g	Fat_g	Sat_g	Mono_g	Poly_g	Chol_mg	Fiber	Per_Pro
	13.50											
			2007.71	71.38	324.60	51.40	16.59	17.98	13.35	92.98	25.60	0.14
	8.00		1138.30	38.40	201.62	20.77	6.64	7.99	3.69	64.98	8.70	0.13
2.10	7.60		2319.31	64.65	352.16	77.72	30.28	29.04	12.57	202.23	22.04	0.11
2.21	6.00		2036.47	70.48	333.77	51.54	19.46	16.93	10.69	175.32	20.55	0.14
2.03	5.10		2121.46	65.79	332.68	63.46	25.94	22.57	10.03	298.40	21.05	0.12
2.15	5.30	8.70	1999.51	58.94	305.37	53.31	16.16	22.60	10.47	91.27	23.44	0.12
			1631.07	56.39	236.65	48.48	17.52	16.62	9.30	135.76	14.50	0.14
			2531.64	90.26	475.87	37.80	12.87	10.86	9.90	49.52	44.25	0.14
			2323.39	90.39	290.85	78.73	25.05	30.73	16.87	225.03	19.05	0.16
1.84	3.60	5.20	2677.89	72.50	407.63	83.16	28.25	29.67	19.10	162.63	29.74	0.11
			2836.91	63.11	396.12	119.48	47.29	42.22	22.22	248.71	28.02	0.09
2.08			2016.20	92.63	234.29	78.81	26.30	31.18	14.03	303.40	19.61	0.18
1.53	4.00	6.90	1680.05	42.53	258.62	56.94	22.81	20.28	10.31	103.74	14.17	0.10
			2416.92	69.32	281.11	103.26	38.65	38.75	18.69	250.55	10.98	0.11
	5.20		2020.38	66.26	281.26	76.68	24.11	31.21	15.95	116.64	26.28	0.13
	3.20											
			2127.56	90.01	252.67	67.52	22.52	25.08	14.55	253.72	12.73	0.17
			2058.29	72.30	314.40	60.58	19.59	23.23	12.64	225.17	15.24	0.14
			1817.84	65.90	238.15	69.41	19.25	26.10	19.33	162.65	11.45	0.15
			2280.27	101.18	319.58	75.06	30.30	28.11	10.94	252.19	27.41	0.18
1.82	3.80											
			1535.32	55.35	188.97	64.12	24.57	24.99	10.23	146.86	8.42	0.14
	7.60		1761.96	60.42	186.03	87.08	29.86	35.34	15.49	303.57	9.52	0.14
			1667.50	63.70	233.01	56.31	18.48	22.83	10.39	218.68	15.16	0.15
			1956.43	56.37	286.73	70.95	23.01	29.70	12.63	120.58	14.37	0.12
			2601.43	96.84	365.01	88.14	32.10	34.42	15.91	212.23	16.19	0.15
1.48	22.70											
			1555.84	67.71	216.07	49.08	16.98	18.07	10.77	127.69	15.58	0.17

			2202.20	77.63	356.55	60.79	17.13	24.50	14.29	101.15	36.30	0.14
			2193.51	72.80	277.22	85.15	31.01	33.14	15.29	176.10	17.68	0.13
			1333.46	37.95	225.36	30.81	9.14	13.46	6.08	26.51	16.16	0.11
	11.60		1308.49	46.55	135.26	64.83	21.61	23.75	14.87	161.44	9.46	0.14
			2094.46	66.65	339.28	54.81	17.81	19.38	13.92	136.24	20.56	0.13
	15.70		1725.88	53.18	289.50	43.11	11.85	17.24	10.26	55.22	18.75	0.12
			2918.01	64.77	477.62	94.73	26.63	37.31	23.65	212.51	39.67	0.09
			1720.19	48.01	201.58	77.93	33.12	27.30	12.42	139.51	11.61	0.11
			1858.08	56.61	289.30	60.33	21.05	22.57	12.12	184.74	24.86	0.12
			1779.39	93.27	227.15	56.54	18.78	22.18	10.95	235.73	10.82	0.21
			1713.07	51.79	244.46	51.54	21.50	17.17	9.24	177.23	18.73	0.12
2.02	14.20	6.80	1537.66	79.28	219.16	38.89	14.36	13.37	7.37	192.08	8.78	0.21
1.73			2020.31	62.75	253.05	77.53	23.18	31.04	17.73	182.98	12.78	0.12
			2280.86	90.38	260.24	99.53	37.11	38.12	16.59	382.09	11.78	0.16
			2707.15	83.86	366.34	91.48	29.09	30.52	25.28	204.19	21.37	0.12
			1564.22	64.97	182.94	46.81	14.47	17.93	10.91	125.52	13.35	0.17
2.01	3.80		2237.26	79.47	292.47	78.29	30.69	27.73	13.98	247.86	20.86	0.14
2.65	4.60	4.30	2359.87	77.28	350.09	65.81	19.69	24.28	16.60	175.46	21.28	0.13
	10.30		1256.11	61.67	182.43	29.30	10.31	10.80	5.47	91.33	14.47	0.20
			1550.30	45.65	221.49	56.07	16.33	22.75	12.89	76.67	11.60	0.12
			2259.13	68.51	283.54	98.53	32.46	36.08	24.14	131.33	10.67	0.12
			1916.19	121.35	219.17	59.95	19.88	23.64	10.43	299.32	10.52	0.25
1.73			1659.36	45.34	284.88	43.41	15.64	16.32	8.25	130.48	11.72	0.11
			1692.49	62.17	201.33	75.25	25.49	28.76	15.54	297.71	19.23	0.15
1.45	11.00		1881.46	73.02	237.96	54.84	19.01	21.92	9.27	156.76	17.39	0.16
	11.40											
			2140.49	77.11	397.59	32.05	12.28	11.62	5.13	53.91	32.45	0.14
			1804.21	55.36	270.44	55.53	19.90	20.58	10.94	94.79	17.60	0.12
1.86			3463.25	109.27	499.09	122.66	51.39	43.65	19.56	293.97	17.93	0.13

1.61	5.20	4.50	2632.17	78.23	390.05	92.50	30.39	34.58	21.33	216.92	27.57	0.12
			2209.65	65.14	289.90	92.33	30.58	34.59	20.55	159.34	11.52	0.12
			1097.32	27.12	164.24	41.70	20.85	13.01	4.90	80.75	22.01	0.10
			1894.82	85.08	268.59	55.73	19.05	20.24	12.19	219.22	12.86	0.18
			1891.99	57.71	308.02	53.39	14.20	22.53	12.70	30.29	36.85	0.12
			1283.08	60.35	164.21	44.72	14.53	16.86	9.25	165.29	10.80	0.19
			1670.69	81.60	264.35	57.86	23.40	29.19	14.82	265.61	18.46	0.20
1.64	4.70	5.10	2171.70	70.95	302.94	52.59	19.06	20.08	8.86	213.17	17.41	0.13
			2528.70	88.43	351.78	89.06	30.34	31.46	21.30	234.18	25.01	0.14
			1534.67	49.73	211.30	58.70	18.46	20.36	15.76	203.25	13.86	0.13
	6.40											
1.63	10.70	25.20	1778.28	75.99	198.31	60.21	21.07	24.10	9.83	479.40	7.10	0.17
			2279.52	88.61	332.44	68.47	23.54	25.45	13.61	271.23	20.39	0.16

per_CHO	per_Fat	Fat_Sat	Fat_Mon	Fat_Pol
per_CHO	per_Fat	Fat_Sat	Fat_Mon	Fat_Pol
0.65	0.23	0.32	0.35	0.26
0.71	0.16	0.32	0.38	0.18
0.61	0.30	0.39	0.37	0.16
0.66	0.23	0.38	0.33	0.21
0.63	0.27	0.41	0.36	0.16
0.61	0.24	0.30	0.42	0.20
0.58	0.27	0.36	0.34	0.19
0.75	0.13	0.34	0.29	0.26
0.50	0.30	0.32	0.39	0.21
0.61	0.28	0.34	0.36	0.23
0.56	0.38	0.40	0.35	0.19
0.46	0.35	0.33	0.40	0.18
0.62	0.31	0.40	0.36	0.18
0.47	0.38	0.37	0.38	0.18
0.56	0.34	0.31	0.41	0.21
0.48	0.29	0.33	0.37	0.22
0.61	0.26	0.32	0.38	0.21
0.52	0.34	0.28	0.38	0.28
0.56	0.30	0.40	0.37	0.15
0.49	0.38	0.38	0.39	0.16
0.42	0.44	0.34	0.41	0.18
0.56	0.30	0.33	0.41	0.18
0.59	0.33	0.32	0.42	0.18
0.56	0.30	0.36	0.39	0.18
0.56	0.28	0.35	0.37	0.22

0.65	0.25	0.28	0.40	0.24
0.51	0.35	0.36	0.39	0.18
0.68	0.21	0.30	0.44	0.20
0.41	0.45	0.33	0.37	0.23
0.65	0.24	0.32	0.35	0.25
0.67	0.22	0.27	0.40	0.24
0.65	0.29	0.28	0.39	0.25
0.47	0.41	0.42	0.35	0.16
0.62	0.29	0.35	0.37	0.20
0.51	0.29	0.33	0.39	0.19
0.57	0.27	0.42	0.33	0.18
0.57	0.23	0.37	0.34	0.19
0.50	0.35	0.30	0.40	0.23
0.46	0.39	0.37	0.38	0.17
0.54	0.30	0.32	0.33	0.28
0.47	0.27	0.31	0.38	0.23
0.52	0.31	0.39	0.35	0.18
0.59	0.25	0.30	0.37	0.25
0.58	0.21	0.35	0.37	0.19
0.57	0.33	0.29	0.41	0.23
0.50	0.39	0.33	0.37	0.25
0.46	0.28	0.33	0.39	0.17
0.69	0.24	0.36	0.38	0.19
0.48	0.40	0.34	0.38	0.21
0.51	0.26	0.35	0.40	0.17
0.74	0.13	0.38	0.36	0.16
0.60	0.28	0.36	0.37	0.20
0.58	0.32	0.42	0.36	0.16

0.59	0.32	0.33	0.37	0.23
0.52	0.38	0.33	0.37	0.22
0.60	0.34	0.50	0.31	0.12
0.57	0.26	0.34	0.36	0.22
0.65	0.25	0.27	0.42	0.24
0.51	0.31	0.32	0.38	0.21
0.63	0.31	0.40	0.50	0.26
0.56	0.22	0.36	0.38	0.17
0.56	0.32	0.34	0.35	0.24
0.55	0.34	0.31	0.35	0.27
0.45	0.30	0.35	0.40	0.16
0.58	0.27	0.34	0.37	0.20